Corrosion

PROTECT or PAY

You have no other choice!

There are just two reasons why corrosion costs industry over $6,000,000,000 annually:

1. To the layman, corrosion usually means only visible rust—thus many surfaces are left unprotected until irreparable damage is done.
2. Too often conventional coatings are relied on to protect under conditions for which they are neither designed nor suited.

Don't risk needless loss from either cause. Protect all critical surfaces with Amercoat – the products designed to give *extra protection* against surface failure. Highly resistant to a wide variety of chemicals, brines, fumes, weathering and abrasion, they are available in a number of formulas, each built to meet specific conditions.

No business escapes the effects of corrosion. You must protect or pay, and it will pay you to protect *now* with Amercoat.

Check these danger points...

Piping • Machinery
Walls and Ceilings
Fixtures • Tanks
Floors • Conveyors
Laboratory Equipment
. . . and all other areas exposed to agents of corrosion or contamination

AMERCOAT CORPORATION

A Division of
American Pipe and Construction Co.
4809 Firestone Blvd., South Gate, California

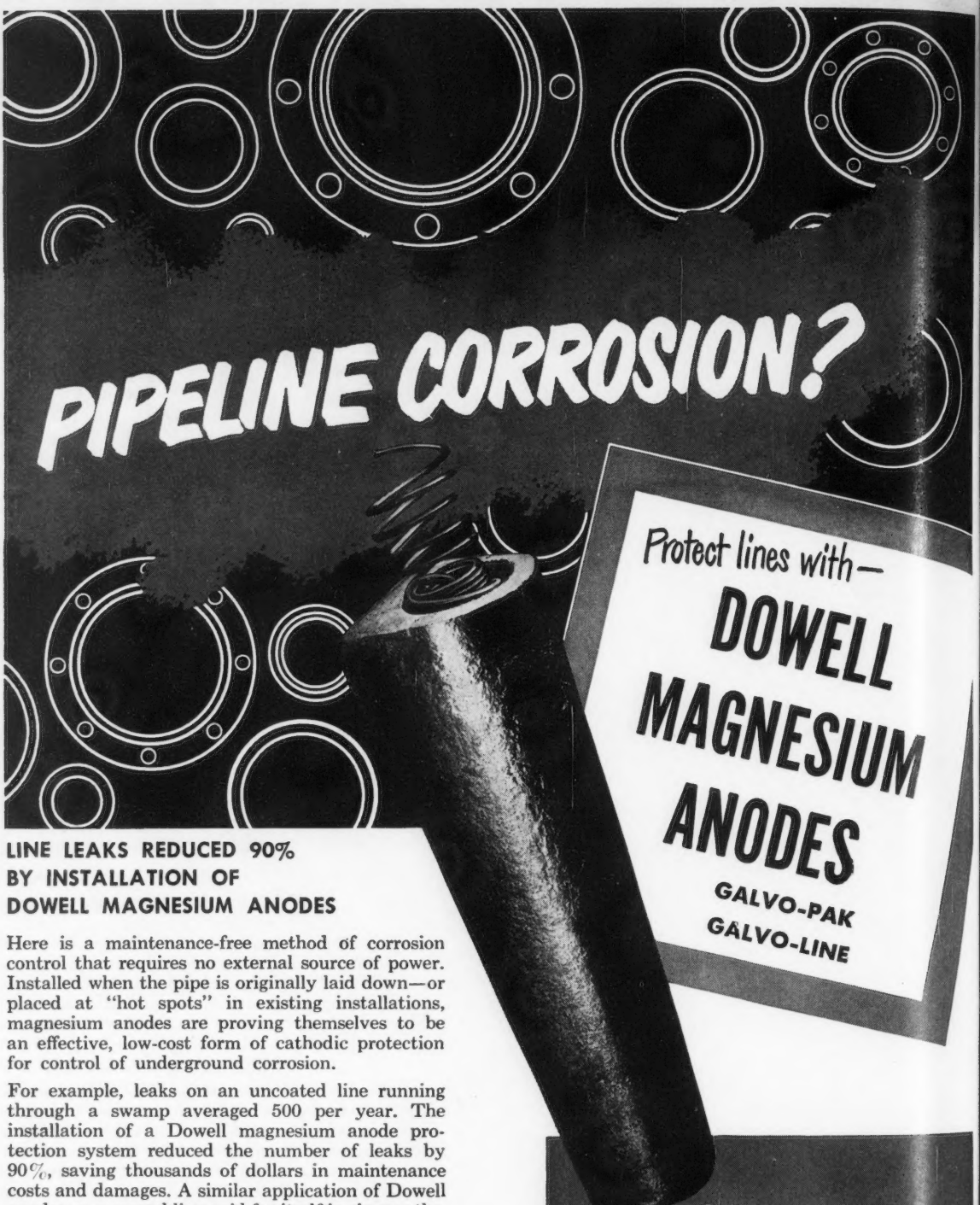
FOLLOW THE LINE OF *most* RESISTANCE

JUNKED BEFORE ITS TIME–

This costly storage tank, due to failure of a conventional coating, served but half its life expectancy. The result—thousands of dollars for replacement, interrupted operations and needless waste.

Putting Permanence
in Pipe

MAYES BROS.
INCORPORATED
HOUSTON



**LINE LEAKS REDUCED 90%
BY INSTALLATION OF
DOWELL MAGNESIUM ANODES**

Here is a maintenance-free method of corrosion control that requires no external source of power. Installed when the pipe is originally laid down—or placed at "hot spots" in existing installations, magnesium anodes are proving themselves to be an effective, low-cost form of cathodic protection for control of underground corrosion.

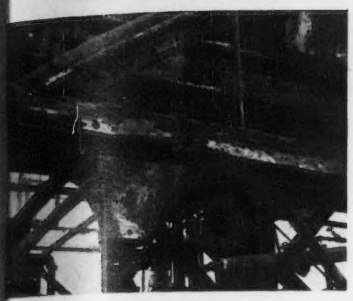
For example, leaks on an uncoated line running through a swamp averaged 500 per year. The installation of a Dowell magnesium anode protection system reduced the number of leaks by 90%, saving thousands of dollars in maintenance costs and damages. A similar application of Dowell anodes on a second line paid for itself in six months.

For magnesium anodes, look to Dowell, a subsidiary of The Dow Chemical Company which developed this effective form of cathodic protection. Dowell engineers can give you the full benefit of their long association with the petroleum industry—plus the joint research of both Dow and Dowell. For complete information, write to Tulsa.

DOWELL INCORPORATED
TULSA 3, OKLAHOMA
Subsidiary of The Dow Chemical Company

Look to
DOWELL

MAGNESIUM ANODES FOR
CORROSION CONTROL



THIS MONTH'S COVER—This view of an Eastern seaboard chemical manufacturing plant shows deterioration through lack of maintenance in a chemical-marine atmosphere. The building was so badly damaged by corrosion it was demolished. This photograph released through Technical Department, Tar Products Division, Koppers Company, Inc., with customer's consent.

☆

STAFF

EDITORIAL

IVY M. PARKER—*Editor*

NORMAN E. HAMNER—*Managing Editor*

CORRESPONDENTS

B. B. MORTON—*Non-Ferrous Metals*

HENRY W. FOELSCH—*Pulp, Paper, Mining and Food*

ARBA H. THOMAS—*Ferrous Metals*

W. E. HUDDLESTON—*Petroleum Production and Pipe Lines*

IRWIN C. DIETZE—*Power*

GUSTAVE HEINEMANN—*Chemical Process*

R. H. BROWN—*Light Metals*

DERK HOLSTEYN—*Petroleum Refining*

J. W. DANSER—*Telephone, Telegraph, Radio*

R. MCFARLAND—*Non-Metals*

L. M. MOSHER—*Transportation Industry*

T. E. LARSON—*Fresh and Salt Water*

ADVERTISING

A. B. CAMPBELL—*(Executive Secretary of NACE) Advertising Manager*

☆

GENERAL OFFICES

919 Milam Building
803 Texas Avenue
Houston 2, Texas

Subscription: $7.50 per year to non-members; Member's dues $7.50, of which $3.00 are applied as subscription to CORROSION; Special rate, $3.50 per year for public libraries and libraries of educational institutions. Additional copies to members 50 cents, to non-members, 75 cents. Foreign remittances should be by international postal or express money order or bank draft negotiable in the U. S. for an equivalent amount in U. S. funds.

Entered as second class matter October 31, 1946, at the Post Office at Houston, Texas, under the act of March 3, 1879.

CORROSION is Indexed Regularly by Engineering Index.

Corrosion *devoted entirely to* CORROSION

Research and Control

Published monthly as its official journal, by the National Association of Corrosion Engineers, Inc., at Houston, Texas, U. S. A., to provide a permanent record of progress in the control of corrosion as described in papers prepared for the Association and from other sources.

VOL. VI JULY, 1950 NO. 7

CONTENTS

Page

Directory of NACE Regional and Sectional Officers ..... iv, v

Directory of Technical Practices Committee Officers vii

TECHNICAL SECTION

Water Side Deterioration of Diesel Engine Cylinder Liners
By F. N. Speller and F. L. LaQue 209

Cathodic Protection of Fourteen Offshore Drilling Platforms
By E. P. Doremus and G. L. Doremus 216

A Rust-Preventing Pickling Inhibitor
By Karl F. Hager and Morris Rosenthal 225

Cathodic Protection of An Active Ship in Sea Water
By K. N. Barnard and G. L. Christie 232

NACE REGIONAL AND SECTIONAL NEWS

	Page		Page
Hoxeng Elected at Cleveland	2	Sabine-Neches Section Elects	2
TP-6 Adds Masonry Division	2	NACE Calendar	4
Vance N. Jenkins III	2	NACE New, Reinstated Members, Changes of Address	9
Billhartz Addresses N. Texas	2	New NACE Corporate Members	14
St. Louis Names Officers	2	Corpus Christi Meets	5

GENERAL NEWS OF CORROSION INTEREST

Topic of the Month—Results of Galvanic Corrosion Tests Involving 9% and 5% Nickel Steel Tubing Coupled to N-80 Casing	1	Electrochemical Society Officers Named	5
		Corrosion Problems	7
		Sea Horse Institute Meets	8
Phosphorus Alloys' Corrosion Resistance Cited	4	Corrosion Clippings	8
		Mid-year Directory Dropped	8
		Weather Deck Coating System Is Sought	16
Desirable Qualities of Phosphoric Acid as Scale Remover	4	Revised Abstract Index	20
		ASM New Officers Named	20
		New Products	22

CORROSION ABSTRACTS, INDEX ON 27

INDEX TO ADVERTISERS 39

Copyright 1950 by the National Association of Corrosion Engineers. Reproduction of the contents, either as a whole or in part, is forbidden unless specific permission has been obtained from the Editor of CORROSION. Articles presented represent the opinions of their authors, and not necessarily those of the Editors of CORROSION, nor the Officers or Members of the National Association of Corrosion Engineers. Manuscripts to be considered for publication should be forwarded, together with illustrations, to the Editor of CORROSION, 919 Milam Building, Houston 2, Texas.

Directory of NACE Regional and Sectional Officers

NORTH EAST REGION

R. H. LYNCH, Director
Keystone Pipe Line Co.,
260 South Broad Street,
Philadelphia 1, Penna.

LEWIS B. DONOVAN, Chairman
Consolidated Edison Co.
of New York Inc.,
4 Irving Place,
New York 3, N. Y.

HUGH L. HAMILTON,
Vice-Chairman
Keystone Pipe Line Co.,
260 S. Broad St.,
Philadelphia, Pa.

E. ROWLAND ENGLISH,
Sec.-Treas.
H. C. Price Co.,
P. O. Box 6120,
Philadelphia 15, Pa.

• Metropolitan Section (N.Y.)

T. P. MAY, Chairman
International Nickel Co., Inc.
67 Wall Street
New York 5, N. Y.

H. W. WAHLQUIST, Vice-Chair.
Ebasco Services, Inc.,
2 Rector Street,
New York, N. Y.

F. J. LeFEBVRE, Sec.-Treas.
Electro Rust-Proofing Corp.
(N. J.)
1 Main Street,
Belleville 9, N. J.

• Philadelphia Section

ROBERT R. PIERCE, Chairman
Pennsylvania Salt Mfg. Co.,
1000 Widener Bldg.,
Philadelphia, Pa.

HENRY F. McCONOMY, Vice-Chair.
The Atlantic Refining Co.,
P. O. Box 8138,
Philadelphia, Pa.

ERNEST H. WYCHE, Sec.-Treas.
Lukens Steel Co.,
Coatesville, Pa.

• Baltimore Section

EDGAR F. WOLF, Chairman
Cons. Gas Electric Light and
Power Co. of Baltimore,
531 East Madison St.,
Baltimore 3, Md.

HOMER D. HOLLER, Vice-Chairman
National Bureau of Standards,
Room 207, East Building,
Washington 25, D. C.

GEORGE E. BEST, Sec.-Treas.
Mutual Chemical Co. of Am.,
1348 Block Street,
Baltimore 31, Md.

• Pittsburgh Section

RUSSELL H. COE, Chairman
Pittsburgh Coke & Chemical
Co., P. O. Box 1645,
Pittsburgh 19, Pa.

V. V. KENDALL, Vice-Chairman
National Tube Co.,
Box 266,
Pittsburgh, Pa.

J. M. BIALOSKY, Treasurer
Carnegie-Illinois Steel
Corp., 210 Semple St.,
Pittsburgh 13, Pa.

E. D. VERINK, JR., Secretary
Aluminum Co. of America,
P. O. Box 1012,
New Kensington, Pa.

W. W. BINGER, Asst. Secretary
Research Laboratories,
Aluminum Co. of America,
New Kensington, Pa.

NORTH CENTRAL REGION

FRANK L. WHITNEY, Jr., Dir.,
Monsanto Chemical Co.,
1700 S. Second St.,
St. Louis, Mo.

L. G. VANDE BOGART, Chairman
Crane Co., Engineering & Res.
Div., 836 South Michigan Ave.
Chicago 5, Illinois

WALTER J. SANDEL, Vice-Chair.
Coatings for Industry, Inc.
2185 East 18th Street,
Cleveland 15, Ohio

R. A. SHOAN, Sec.-Treas.
Dearborn Chemical Company,
1029 West 35th Street,
Chicago 9, Illinois

• Chicago Section

VICTOR J. PAYTON, Chairman
Comonwealth Edison Co.,
72 West Adams St.,
Chicago, Ill.

FRANKLIN M. WATKINS,
Vice-Chair.
Sinclair Refining Co.,
400 East Sibley Blvd.,
Harvey, Ill.

C. A. VAN NATTA, Secretary
Plastic Lining Corp.,
914 South Wabash Ave.,
Chicago, Ill.

LAURIE E. NICHOLLS, Treasurer
Public Service Corp. of
Northern Illinois,
1001 South Taylor Ave.,
Oak Park, Ill.

• Cleveland Section

RAYMOND B. HOXENG, Chairman
Case Institute of Tech.,
University Circle,
Cleveland, Ohio

L. W. DAVIS, Vice-Chairman
Aluminum Co. of Am.,
2210 Harvard Ave.,
Cleveland, Ohio

CHARLES N. DETRICK, Sec.-Treas.
Williams & Co., Inc.,
3700 Perkins Ave.,
Cleveland, Ohio

• Greater St. Louis Section

FRANK L. WHITNEY, Chairman
Monstanto Chem. Co.,
1700 S. Second St.,
St. Louis, Mo.

GEORGE FISHER, Vice-Chair.
The International Nickel Co.,
411 N. 7th St.,
St. Louis, Mo.

CHARLES SWARTOUT, Secretary
Mallinckrodt Chem. Co.,
3600 N. 2nd St.,
St. Louis, Mo.

GEORGE PURDY, Treasurer
Tretolite Company,
937 Pacific Ave.,
St. Louis 19, Missouri

SOUTH EAST REGION

JAMES T. MacKENZIE, Director
Amer. Cast Iron Pipe Co.,
P. O. Box 2603,
Birmingham 3, Alabama

J. W. YELDELL, Chairman
Southern Natural Gas Co.,
Box 2563,
Birmingham, Ala.

E. P. TAIT, Vice-chair.
Alloy Steel Prod. Co.,
Candler Bldg.,
Atlanta, Ga.

J. F. JOHNSTON, Sec.-Treas.
Am. Telephone & Tel. Co.,
51 Ivy St., N. E.,
Atlanta, Ga.

SOUTH CENTRAL REGION

T. F. P. KELLY, Director
James E. Mavor Co.,
Houston, Texas

TOM R. STATHAM, Chairman
Magnolia Pipe Line Co.,
Dallas, Texas

GEORGE A. MILLS, Vice-Chair.
Central Power & Lt. Co.,
Corpus Christi, Texas

M. C. FLEMING, Sec.-Treas.
Phillips Petroleum Co.,
Bartlesville, Okla.

HARRY E. WALDRIP, Asst. Sec.-
Treas.
Gulf Oil Corp.,
Houston, Texas

• Tulsa Section

F. T. GARDNER, Chairman
University of Tulsa,
Tulsa, Okla.

F. E. PYEATT, JR., Vice-Chairman
Mid-Continent Pipe Line Co.
P. O. Box 381
Tulsa 2, Okla.

FRANK E. McNULTY, Sec.-Treas.
Pittsburgh Coke & Chem. Co.
Room 711, Thompson Bldg.,
Tulsa, Okla.

• Houston Section

OLIVER OSBORN, Chairman
Dow Chemical Company,
Freeport, Texas

P. P. SPAFFORD, Vice-Chair.
Stanolind Oil & Gas Co.
Box 3092,
Houston, Texas

LAYTON C. TUGGLE, Sec.-Treas.
Shell Oil Refinery,
Box 2527,
Houston, Texas

• University of Houston Junior Section

WM. G. BOYD, JR., Chairman

FRED KRCH, Vice-Chair.
National Lead Co.,
City National Bank Bldg.,
Houston, Texas

EMMETT O. BAMMEL, JR., Treas.
1806 Colquitt St.,
Houston, Texas

EDW. J. MULVANEY, JR., Sec.
606 S. Kansas St.,
Pasadena, Texas

JOHN P. ROBERTS, Sr. Fac. Adv.
Assoc. Prof. Metallurgy,
111 East 22nd St.,
Houston, Texas

• Shreveport Section

M. W. BELSON, Chairman
D. E. Stearns Co.
P. O. Box 1234
Shreveport, La.

H. V. BEEZLEY, Vice-Chair.
United Gas Corp.,
Shreveport, La.

M. J. OLIVE, Secretary
Arkansas Natural Gas Co.
Shreveport, La.

J. A. CREEVY, Treasurer
Youngstown Sheet & Tube Co.
Shreveport, La.

• North Texas Section

K. D. WAHLQUIST, Chairman
6281 Revere Place
Dallas 14, Texas

JOHN R. LIGON, Vice Chair.
Sinclair Ref. Co.
901 Fair Bldg.
Ft. Worth, Texas

JOHN L. POOL, Sec.-Treas.
Magnolia Pipe Line Co.
618 Magnolia Bldg., Box 900
Dallas, Texas

N. H. SIMPSON, Asst. Sec.-Treas.
Consol. Vultee Aircraft Corp.
Grants Lane
Ft. Worth, Texas

• Corpus Christi Section

JOHN G. CAMPBELL, Chairman
Box 1913,
Corpus Christi, Texas

BUFORD P. LEDBETTER, Vice-Chair.
Gas Department, City of
Corpus Christi, Texas

THOMAS S. MOFFAT, Sec.-Treas.
Southern Alkali Corp.,
Lawrence Drive,
Corpus Christi, Texas

• Permian Basin Section

AARON GENSBERG, Chairman
Gulf Oil Corp.,
Drawer 4232
Odessa, Texas

H. D. MURRAY, Vice-Chair.
The Texas Co.,
Box 1270
Midland, Texas

ROY H. ZUEFELDT, Sec.-Treas.
The Texas Co.,
P. O. Box 903,
Jal, New Mexico

(Continued Next Page)

Directory of NACE REGIONAL and SECTIONAL OFFICERS

SOUTH CENTRAL REGION

• Sabine-Neches Section

JOSEPH J. PICARAZZI, Chair.
Cities Serv. Ref. Co.,
Lake Charles, La.

RICHARD P. CLARKE, Vice-Chair.
Atlantic Refining Co.,
Port Arthur, Texas

FRANK R. JELINEK, Sec.-Treas.
Neches Butane Prod. Co.,
Port Neches, Texas

WESTERN REGION

I. C. DIETZE, Director
Dept. of Water and Power,
City of Los Angeles,
141 South Martel Avenue,
Los Angeles, California

DAVID T. JONES, Chairman
The Pacific Tel. & Tel. Co.,
4364 Farmdale Ave.,
North Hollywood, Cal.

L. L. WHITENECK, Vice-Chair.
Long Beach Harbor Dept.,
1333 El Embarcadero,
Long Beach 7, Cal.

W. M. SCHILLING, Sec.-Treas.
Southern Counties Gas Co.,
4818 Beck Ave.,
Bell, Cal.

• San Francisco Bay Area Section

ARTHUR E. STORM, Chairman
Tide Water Assoc. Oil Co.
Associated, Cal.

R. J. KING, Vice-Chairman
Standard Oil Co. of Cal.

WILLIAM R. STAPLES, Sec.-Treas.
Carpenter Steel Co.,
24 California St.,
San Francisco, Cal.

• Salt Lake Section

HARRY R. BROUGH, Chairman
Mountain Fuel Supply Co.
36 South State St.,
Salt Lake City, Utah

GEORGE R. HILL, Vice-Chair.
3725 South 11th East St.,
Salt Lake City, Utah

JOHN W. COX, Sec.-Treas.
Pipe Line Division,
Utah Oil Refining Co.,
Utah Oil Building,
Salt Lake City, Utah

• Los Angeles Section

DAVID T. JONES, Chairman
The Pacific Tel. & Tel. Co.,
4364 Farmdale Ave.,
North Hollywood, Cal.

L. L. WHITENECK, Vice-Chair.
Long Beach Harbor Dept.,
1333 El Embarcadero,
Long Beach 7, Cal.

W. M. SCHILLING, Sec.-Treas.
Southern Counties Gas Co.,
4818 Beck Ave.,
Bell, Cal.

Atlas research announces

ALKOR 5E

the superior acid and alkali proof cement for joining brick and tile

This is the news you have waited for, ALKOR 5E, the nearest thing to a universal corrosion-resistant cement. Check these properties: Inert to all solvents and alkalies; Resistant to all non-oxidizing acids; No appreciable shrinkage on setting; No obnoxious odors; Excellent workability; Easily tooled; Adhesion to wire cut brick greater than 500 psi; Tensile strength 1500 psi; Compressive strength 15,000 psi; Heat accelerates setting only, no fumes or smoke; Sets in less than 24 hrs. at 70° F. For complete information write us at 40 Walnut Street, Mertztown, Penna.

Corrosion Proof LININGS | Corrosion Proof CEMENTS | Corrosion Proof COATINGS | Corrosion Proof FLOORS | Corrosion Proof TANKS

A COMPLETE LINE OF CORROSION-PROOF CONSTRUCTION MATERIALS

THE ATLAS MINERAL PRODUCTS COMPANY
MERTZTOWN, PENNA. HOUSTON, TEXAS

SOMASTIC*

..."ONLY 20 years old, but what a record!"

20 YEARS is a long time on the job, preventing corrosion damage to underground pipe. SOMASTIC Pipe Coating has furnished complete protection at severely corrosive locations since its first year—1930.

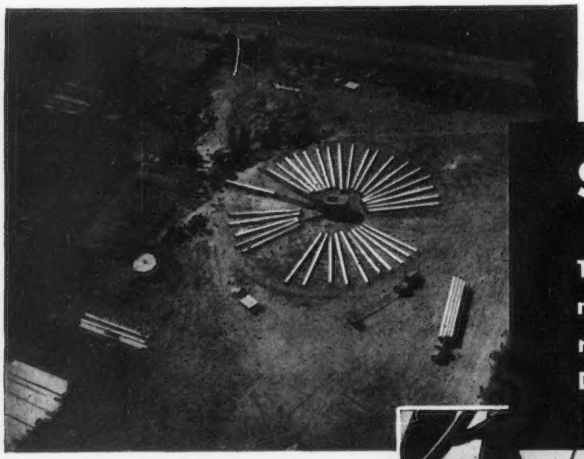
In fact, our knowledge of its useful life is limited only by the total time it has been in existence.

SOMASTIC IS The Best PIPE COATING

2 ECONOMICAL METHODS OF APPLICATION:

... by Central Plant

... by portable Railhead Plant



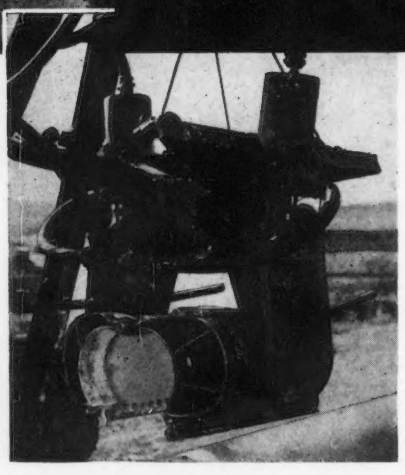
SOMASTIC PIPE COATING

*Reg. U. S. Patent Office

The sure protection of impervious asphalt-mastic—won't distort under soil stresses; resists shock; prevents electrolysis. Ductile; inert; firmly bonded to pipe.

RAILHEAD PLANT. Choice between railhead and central plant depends on the economics of a specific job.

HYDRAULIC FORM. Field joints make SOMASTIC protection continuous along the entire coated line.



Inquiries invited

H. C. PRICE CO.

BARTLESVILLE, OKLAHOMA
PHILADELPHIA, PA.
NEW ORLEANS, LA.

In the 37 States East of the Rocky Mountains

BECHTEL CORPORATION

SAN FRANCISCO and
WILMINGTON, CALIFORNIA

In the 11 Western States and in Foreign Countries

Directory of Technical Practices Committee Officers

M. G. FONTANA, Chairman
The Ohio State University,
Columbus 10, Ohio

EX-OFFICIO MEMBERS

VANCE N. JENKINS
N. E. BERRY
A. B. CAMPBELL

(Chairman of all TP sub-committees listed below are members of the full committee)

TP-1 CORROSION OF OIL AND GAS WELL EQUIPMENT (Formerly Condensate Well Corrosion)

TED S. ZAJAC, Chairman.
Shell Oil Corp., P. O. Box 2099,
Houston, Texas

TP-1A Pacific Coast. E. O. Kartinen, Chairman. Signal Oil & Gas Co., 811 W. Seventh St., Los Angeles 55, Cal.

TP-1B Condensate Well Corrosion. R. C. Buchan, Chairman. Humble Oil & Ref. Co., Houston, Texas.

TP-1C Sweet Oil Well Corrosion. H. L. Bilhartz, Chairman. Altantic Refining Co., Dallas, Texas.

TP-1D Sour Oil Well Corrosion. H. D. Murray, Chairman. Cren-Ray Plastic Prod. Co., Midland, Texas.

TP-1E Bi-Metallic Galvanic Corrosion in Oil and Gas Wells. W. F. Rogers, Chairman. Gulf Oil Corp., Drawer 2100, Houston, Texas.

TP-1F Metallurgy—Oil and Gas Well Equipment. V. V. Kendall, Chairman. National Tube Co., Box 266, Pittsburgh, Pa.

TP-2 GALVANIC ANODES FOR CATHODIC PROTECTION

WALTER P. NOSER, Chairman.
Humble Pipe Line Co., Drawer 2220,
Houston, Texas

TP-2A To Correlate Data From Operating Installations. L. R. Sheppard, Shell Pipe Line Corp., Houston, Texas.

TP-3 ANODES FOR IMPRESSED CURRENTS

DONALD H. BOND, Chairman.
The Texas Pipe Line Company,
P. O. Box 2332, Houston 1, Texas

TP-4 MINIMUM CURRENT REQUIREMENTS FOR CATHODIC PROTECTION

J. M. PEARSON, Chairman
Sun Oil Co.,
Bishop Hollow Road,
Newton Square, Pa.

TP-5 CORROSION PROBLEMS IN PROCESSING AND HANDLING CHEMICALS

MARS G. FONTANA, Chairman.
The Ohio State University,
Columbus 10, Ohio

TP-5A Materials for Handling and Manufacturing Sulfuric Acid. S. W. Shepard, Chairman, American Cyanamid Co., Bound Brook, N. J.

TP-5B Design for Equipment for Corrosive Services. C. M. Shigley, Chairman, The Dow Chemical Co., Freeport, Texas.

TP-5C Sub-Surface Corrosion by Alkaline Solutions. H. W. Schmidt, Chairman, The Dow Chemical Company, 1313 Helen Street, Midland, Mich.

TP-5D Corrosion by Organic Acids and Bases in the Vapor Phase. F. L. Whitney, Monsanto Chemical Co., 1700 S. Second St., St. Louis, Mo.

TP-5E Gasket Materials for Corrosion Service. L. D. Cook, Chairman, Wyandotte Chemical Corp., Wyandotte, Mich.

TP-6 PROTECTIVE COATINGS

KENNETH TATOR, Chairman.
Consulting Engineer, Montour St.
Extension, Coraopolis, Pa.

L. L. WHITENECK, Coordinator
West Coast Division,
Board of Harbor Com.,
Long Beach, Cal.

TP-6A Organic Coatings and Linings for Resistance to Chemical Corrosion. Kenneth Tator, Chairman.

TP-6B Protective Coatings for Resistance to Atmospheric Corrosion. G. G. Sward, Chairman. National Paint, Varnish & Lacquer Ass'n., 1500 Rhode Island Ave., N.W., Washington, D. C.

TP-6C Protective Coatings for Resistance to Marine Corrosion. Raymond P. Devoluy, Chairman. G. A. Woolsey Paint & Color Co., 229 E. 42nd St., New York 17, N. Y.

TP-6D Pipe Line Coatings. (Chairman not appointed).

TP-6E Protective Coatings in Petroleum Production. (Chairman not appointed).

TP-6F Protective Coatings in the Food Industry. G. W. Seagren, Chairman. The Mellon Institute, Pittsburgh, Pa.

TP-6G Surface Preparation for Organic Coatings. A. J. Liebman, Chairman. Dravo Corp, Dravo Building, Pittsburgh 22, Pa.

TP-6H Glass and Vitreous Enamel Linings. G. H. McIntyre, Chairman. Ferro-Enamel Corp., Harvard & 56th St., Cleveland 5, Ohio.

TP-6I Metallic Coatings. (Chairman not appointed).

TP-6J Standards. G. G. Sward, Chairman.

TP-6K Chemical-Resistant Masonry Construction. Robert R. Pierce, Chairman. Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia, Pa.

Available now

First Interim Report
on
Ground Anode Tests
TP-3

Anodes for Impressed
Currents
(Publication 50-1)

60 pp. and cover. Contains results of first year's tests at four ground beds. Tables, curves, conclusions, summarized data.

Per Copy, Postpaid

NACE Members. . $3.00
All Others 5.00

TP-7 MATERIALS FOR USE AT HIGH TEMPERATURES

M. A. SCHEIL, Chairman.
Director Metallurgical Research,
A. O. Smith Corporation,
Milwaukee, Wisconsin

TP-8 CORROSION BY WATERS

V. V. KENDALL, Chairman.
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-9 CORROSION INHIBITORS

A. WACHTER, Chairman.
Shell Development Company, 4560
Horton Street, Emeryville 8, California

TP-10 CORROSION FATIGUE

V. V. KENDALL, Chairman.
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-11 IDENTIFICATION OF CORROSION PRODUCTS

C. M. SCHWARTZ, Chairman.
Battelle Memorial Institute, 505 King
Avenue, Columbus 1, Ohio

TP-12 EFFECT OF ELECTRICAL GROUNDING ON CORROSION

H. L. HAMILTON, Chairman.
Keystone Pipe Line Company,
260 South Broad Street,
Philadelphia 1, Pennsylvania

TP-13 ANNUAL LOSSES DUE TO CORROSION

F. A. ROHRMAN, Chairman
University of Colorado,
Boulder, Colo.

TP-14 INSTRUMENTS FOR CORROSION MEASUREMENTS

RAYMOND F. HADLEY, Chairman.
Susquehanna Pipe Line Co., 1608
Walnut Street, Philadelphia 3, Pa.

TP-15 CORROSION CONTROL IN THE TRANSPORTATION INDUSTRY

MERRITT A. WILLIAMSON, Chairman.
Pullman Standard Car Mfg. Co.,
79 E. Adams, Chicago, Illinois

TP-16 ELECTROLYSIS AND CORROSION OF CABLE SHEATHS

IRWIN C. DIETZE, Chairman.
Dept. of Water & Power,
City of Los Angeles, Cal.

TP-17 STANDARDIZATION OF PROCEDURE FOR MEASURING PIPE LINE COATING CONDUCTANCES

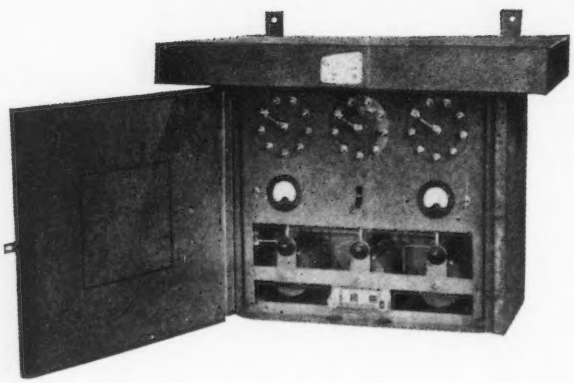
W. E. HUDDLESTON, Chairman.
Huddleston Engineering Co.,
Bartlesville, Okla.

TP-18 INTERNAL CORROSION IN STORAGE AND TRANSPORTATION OF PETROLEUM

L. G. SHARPE, Chairman.
Humble Pipe Line Co.,
Houston, Texas

HERE'S THE SURE DEPENDABLE WAY TO

STOP CORROSION



GOOD-ALL

SELENIUM RECTIFIERS

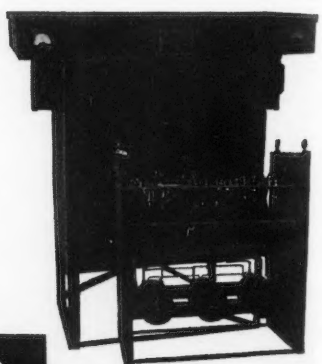
SELF COOLED

LOOK AT THESE ADVANTAGES

- ★ Highest Efficiency
- ★ Self-Cooled or Oil Immersed
- ★ Any Combination D. C. Volt. and Amp. Output
- ★ Choice—Single or Three Phase
- ★ Guaranteed

NOW AVAILABLE AT NEW LOW PRICES

WRITE, WIRE OR PHONE FOR COMPLETE INFORMATION



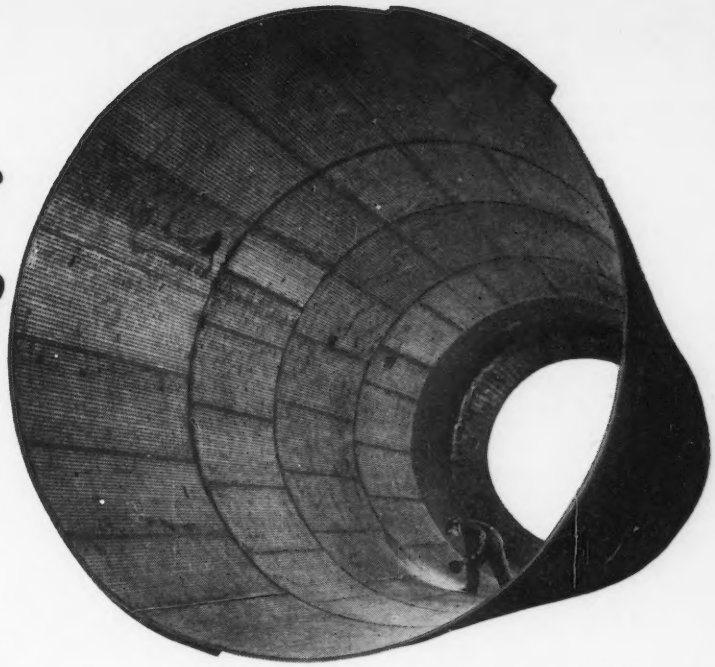
OIL IMMERSED

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA NEBRASKA

PHONES 112 OR 113

Worried about HCl corrosion?



Monel-lined top section of a large fractionating column. Made by the A. O. Smith Corporation for one of the nation's largest oil refiners.

Let MONEL help you keep costs down

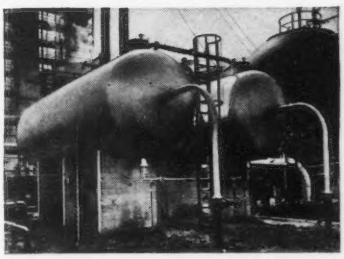
Many years of service experience backed by extensive research, have shown that Monel® has satisfactory resistance to destructive corrosion by hydrogen chloride and hydrochloric acid.

In applications where low concentrations of hydrochloric acid must be handled regularly, Monel vessels and processing equipment have given outstanding service. In petroleum refining, for example, Monel-lined fractionating columns, tanks, and Monel piping and fittings have substantially outlasted other metals.

In addition, Monel is an excellent structural material, possessing high strength, and good workability. Monel can be welded to form corrosion-resistant joints; can be machined, formed, and bent with ordinary shop tools and methods.

Monel is available in all standard mill forms, including seamless tubing and Monel-Clad Steel sheet and plates.

If you have corrosion problems and are looking for ways to preserve product purity or cut maintenance expense, you are invited to consult our Corrosion Engineering Service. Write, explaining your difficulties, and we will put at your disposal a vast accumulation of research and experience data.



Monel-lined tanks installed at the plant of a large Southern oil refiner. Tanks are lined with Monel to combat corrosive action of dilute hydrochloric acid.
The tanks were fabricated by Wyatt Metal & Boiler Works, Houston, Texas.

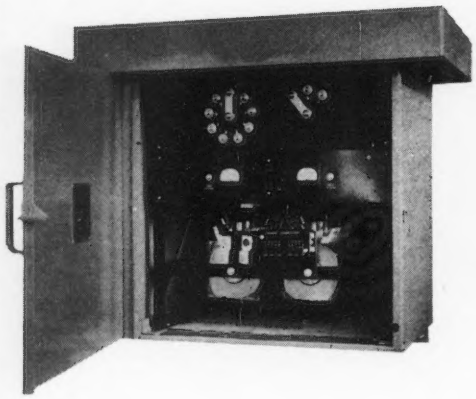
EMBLEM OF SERVICE
NICKEL INCO TRADE MARK ALLOYS

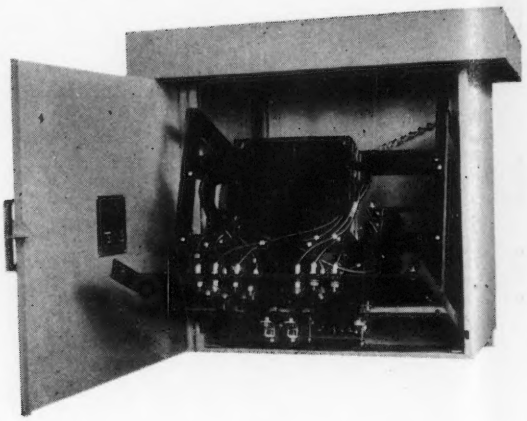
MONEL® • "K"® MONEL • "R"® MONEL • "KR"® MONEL • NICKEL • "D"® NICKEL • "L"® NICKEL INCONEL® • DURANICKEL® • PERMANICKEL® INCONEL "X"®.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

NEW DESIGN

IN AIR COOLED RECTIFIERS





Check the CSC Features:

- √ Hinged panel for easy inspection.
- √ A.C. and D.C. terminals conveniently located on panel. Conduit knock-outs provided below connection terminals.
- √ Easy-change, 27 voltage output selector taps.
- √ Overload magnetic line switches.
- √ Economical installation.
- √ Complete range of sizes and capacities.
- √ Vacuum impregnated heavy duty transformers.
- √ Weather resistant baked enamel housing of 11-gauge steel.
- √ Designed to withstand extreme variances in ambient temperatures, humidities and atmospheric pressures.
- √ Individual ON-OFF switches for meters.
- √ Adaptable to all types of currents and loads.

COMPLETE LINE OF OIL IMMERSED MODELS ALSO AVAILABLE

FOUR WEEKS DELIVERY

CATHODIC SERVICING COMPANY

1024 NORTH OLIE STREET **PHONE 7-5890** **OKLAHOMA CITY, OKLA.**

another Owens-Corning FIRST!

NEW Parallel Reinforced Coromat Pipe Wrap ... 50% Stronger!

Lick Your Problems Aboveground and Below With the Wrap That's Better *NATURALLY!* Now breakage is practically impossible. The parallel reinforcing of glass is stronger weight-for-weight than most steels — and that means more miles per day for the dope man!

Look at the picture. The glass fibers are fine and there are more of them. This means even density, perfect penetration, no holidays.

Made of glass, Coromat is better *naturally* ... has highest resistance to electrolysis and acids. It won't rot. It has highest impact resistance. Dimensionally stable, Coromat has no wicking action, won't take up moisture, won't sag underground.

Backed by science and experience, Coromat is doing a better job everywhere, and the new parallel reinforced Coromat makes the best still better. Why accept less? Get data and samples now!

We originated glass wraps.
We have the facilities.
Our research never ceases.
When better wraps are built, we will build them!

OWENS-CORNING
FIBERGLAS

COROMAT Pipe Wrap

*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with glass fibers. Coromat is the trade-mark of Owens-Corning Fiberglas Corporation.

FREE! Write for booklet, "Corrosion Protection for Underground Pipe", and sample of Coromat.
Owens-Corning Fiberglas Corporation, Dept. 53-G, Toledo 1, Ohio. Branches in principal cities.

FIBERGLAS IS IN YOUR LIFE ... FOR GOOD!

On Ship or Shore, draw on this fund of Anaconda Condenser Tube experience

The condenser installations at the Harbor Steam Plant, Department of Water and Power, Los Angeles, using 272,000 pounds of ANACONDA Super-Nickel Alloy 702 Tubes (70-30 Cupro-Nickel), are typical of American Brass Company technical service.

For 20 years American Brass Technical Department engineers have been studying the growing pollution of cooling water from Los Angeles Harbor—and its corrosion and wear of condenser tubes. Case histories of many installations operating under parallel conditions clearly indicated the use of ANACONDA Super-Nickel Tubes.

But today the pollution of Los Angeles Harbor is beginning to be cleared. Tomorrow a different alloy may be expected to do the job. Then, American Brass Technical Department engineers will document their new recommendations with studies of the new conditions . . . with convincing performance records of the ANACONDA Condenser Tube Alloy that best meets those conditions.

These performance checks of ANACONDA Condenser Tube installations—both marine and stationary—have built experience for which there is no substitute. That experience is yours simply for the asking. Just write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

60117

A Los Angeles Harbor Station condenser containing over 10,100 ANACONDA *Super-Nickel 702 Tubes (70-30 Cupro-Nickel) ⅞ in. O.D. by 26 ft., 3 in. long.*

For efficient heat transfer **ANACONDA®**

CONDENSER TUBES

BARRETT* PROTECTIVE PRODUCTS
COVER EVERY PIPE-COATING NEED

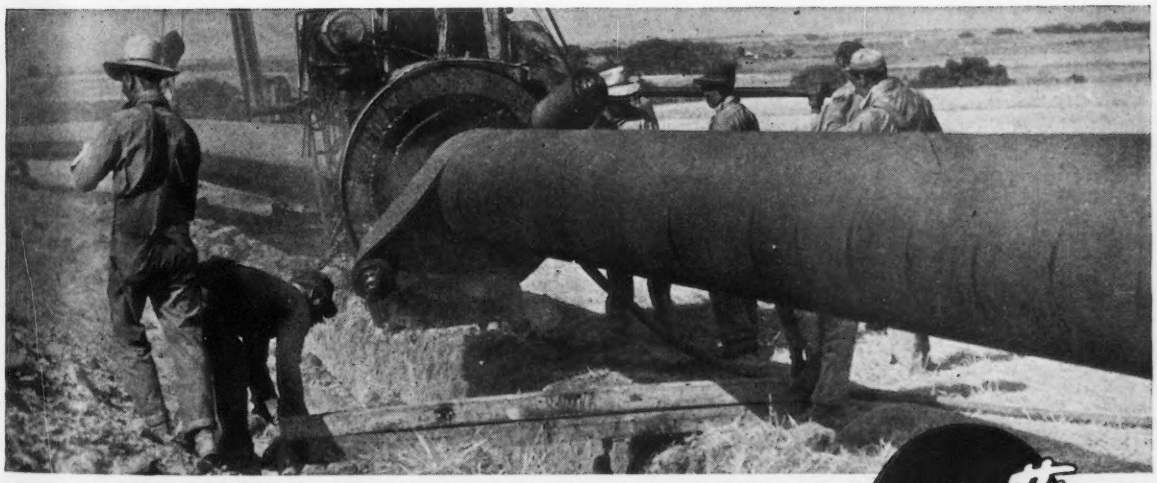
1 **Pipeline Enamel**
2 **Millwrap Enamel**
3 **A.A. Enamel**
4 **Asbestos Felt**
5 **Materials for Special Uses**

BARRETT* ASBESTOS FELT

Barrett* Asbestos Pipeline Felt bonds to the enamel, and shields it from forces which tend to cause enamel penetration, disruption, or displacement. It is flexible enough to withstand curvatures when the coated pipe is handled, and tough enough to prevent shearing at pipe bearing slings.

Asbestos Felt has long been accepted as one of the most durable, most effective, and most economical pipe-wrapping materials known. Barrett coal-tar saturated Asbestos Pipeline Felt is high in the enamel shielding and reinforcing qualities essential to the construction of corrosion-proof pipelines.

This high-quality felt is available in rolls of various widths required by pipeline diameters, and in lengths to suit the different types of coating and wrapping machines.



Memo: **FOR CORROSION ENGINEERS**

Barrett coal-tar materials for special uses are all dependable, durable and economical. Eternium* Paint for exposed metal work. CA-50 Heavy-Duty Cold Application Coating for concrete and metal exposed to extremely corrosive conditions. Marine Enamel for ships, barges and off-shore service vessels. Service Cement and Pipeline Fabric for field joints—no torching required. Asbestos Pipeline Felt for soil stress shield. Tank Bottom Compound for sour crude storage. 34 YB Paint for exposure to salt water spray conditions.

Barrett*

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

*Reg. U. S. Pat. Off.

THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS

is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

(a) To promote the prevention of corrosion, thereby curtailing economic waste and conserving natural resources.

(b) To provide forums and media through which experiences with corrosion and its prevention may be reported, discussed and published for the common good.

(c) To encourage special study and research to determine the fundamental causes of corrosion, and to develop new or improved techniques for its prevention.

(d) To correlate study and research on corrosion problems among technical associations to reduce duplication and increase efficiency.

(e) To promote standardization of terminology, techniques, equipment and design in corrosion control.

(f) To contribute to industrial and public safety by promoting the prevention of corrosion as a cause of accidents.

(g) To foster cooperation between individual operators of metallic plant and structures in the joint solution of common corrosion problems.

(h) To invite a wide diversity of membership, thereby insuring reciprocal benefits between industries and governmental groups as well as between individuals and corporations.

It is an incorporated association without capital stock, chartered under the laws of Texas. Its affairs are governed by a Board of Directors, elected by the general membership. Officers are nominated by (1) the Board of Directors, or (2) a quorum of at least 25 members, and elected by the membership.

Inquiries regarding membership, and all general correspondence should be directed to the Executive Secretary at the administrative headquarters of the National Association of Corrosion Engineers at 919 Milam Building, 803 Texas Avenue, Houston 2, Texas.

Officers, 1950-51

President.....VANCE N. JENKINS
Wilmington, Cal.

Vice-President.....N. E. BERRY
Evansville, Ind.

Treasurer.....R. A. BRANNON
Houston, Texas

Executive Secretary.....A. B. CAMPBELL
919 Milam Building
Houston 2, Texas

Directors

President

VANCE N. JENKINS.....1950-51
Union Oil Company of Cal., Wilmington, Cal.

Vice President

N. E. BERRY.....1950-51
Servel, Inc., Evansville, Ind.

Treasurer

R. A. BRANNON.....1950-51
Humble Pipe Line Company, Houston, Texas

Representing Active Membership

H. D. MURRAY.....1950-53
Cren-Ray Plastic Products Co., Midland, Texas

AARON WACHTER.....1950-53
Shell Development Co., Emeryville, Cal.

PAUL W. BACHMAN.....1949-52
Davison Chemical Corp., Baltimore, Md.

L. J. GORMAN.....1948-51
Consolidated Edison Co. of New York, Inc., New York, N. Y.

Representing Corporate Membership

V. V. MALCOM.....1950-53
The Philip Carey Mfg. Co., Cincinnati, Ohio

D. C. GLASS.....1949-52
Pure Oil Company, Chicago, Ill.

E. D. VERINK, JR.....1949-52
Aluminum Co. of America, New Kensington, Pa.

WARD R. MYERS.....1949-51
E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

D. E. STEARNS.....1948-51
The D. E. Stearns Co., Shreveport, La.

Representing Regional Divisions

FRANK L. WHITNEY, JR..(North Central) 1950-53
Monsanto Chemical Co., St. Louis, Mo.

ROBERT H. LYNCH.....(North East) 1951
Keystone Pipe Line Co., Philadelphia, Pa.

T. F. P. KELLY.....(South Central) 1950-53
James E. Mavor Co., Houston, Texas

IRWIN C. DIETZE.....(Western) 1952
Dept. of Water & Power, City of Los Angeles, Cal.

J. T. MacKENZIE.....(South East) 1951
American Cast Iron Pipe Co., Birmingham, Ala.

Directors Ex Officio

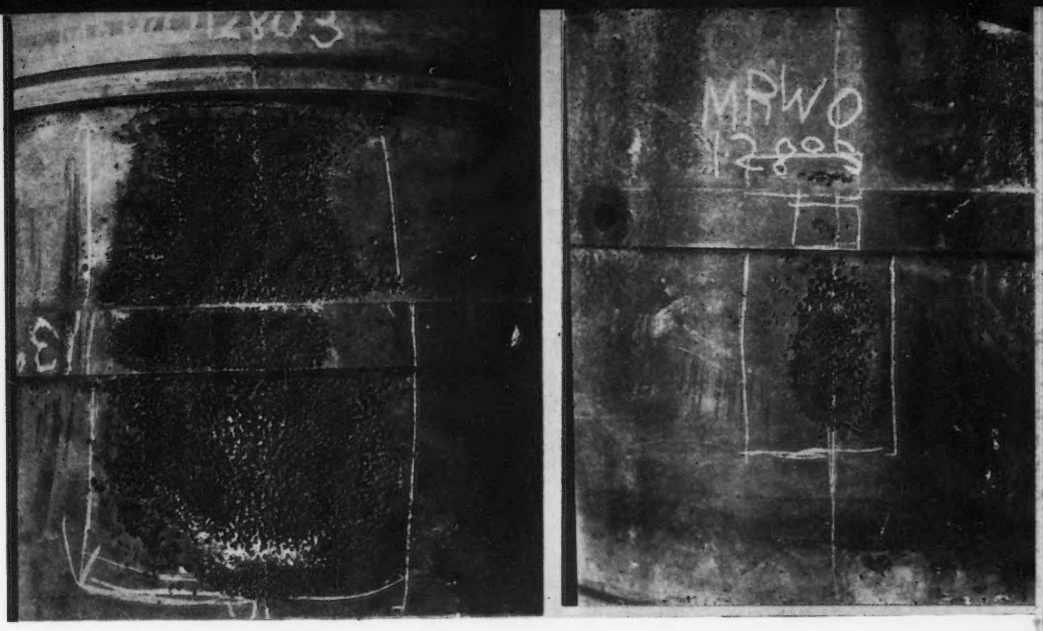
R. B. MEARS, Past President, 1950-51
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.

E. P. NOPPEL, Chairman
Policy and Planning Committee
Ebasco Services, Inc., New York, N. Y.

MARS G. FONTANA, Chairman
Technical Practices Committee
Ohio State University, Columbus, Ohio

IVY M. PARKER, Chairman
Publication Committee
Plantation Pipe Line Co., Bremen, Ga.

L. A. BALDWIN, Chairman
Regional Management Committee
Johns-Manville Sales Corp., New York, N. Y.



Scavenging Side

Exhaust Side

Figure 1—Water side erosion of Diesel engine cylinder liner after service for six months. Bore of cylinder 20½ inches.

Water Side Deterioration Of Diesel Engine Cylinder Liners*

By F. N. SPELLER and F. L. LaQUE***

Abstract

Heretofore cast iron liners have usually required renewal on account of internal wear. The useful life due to internal conditions will probably be extended by improved inhibition and lubrication. This paper deals with problems in water cooling of Diesel engines. The important factors involved are: dissimilar metals, design, concentration cells at juncture of liners with engine block, variable velocities and temperatures, composition of the liner and cooling water and occasional rapid localized pitting, are apparently of dynamic origin. Ordinary corrosion can be controlled in the closed water cooling system by using chromate or other water-soluble inhibitors in soft water low in organic matter. The "dynamic" pitting referred to above is less common but often much more rapid than any electro-chemical pitting of cast iron known to the authors. This type of pitting is illustrated and described in detail. The pits are free from corrosion products. From the shape, contour and limited experimental evidence this peculiar pitting is associated with the high frequently "cavitation" effect found in hydraulic systems. High chromate concentration (4000 ppm) has proved beneficial (the railroads report good results with about 2000 ppm chromate) but the final solution awaits further research and probably the application of damping principles in design.

DURING THE PAST few years the authors have encountered individually a peculiar form of corrosion*** that occurs on the water side of Diesel engine cylinder liners.

It appeared first on liners in tractor engines, and particularly in engines of a certain model. Other models of the same make in which the same cast iron was used for liners and which were operated in the same territories with the same cooling water at the same operating temperatures remained free from the peculiar attack. Furthermore, the attack could be reproduced in the engine laboratory using single cylinder test engines—but again only with cylinders which represented the model which was suffering the damage in the field. Likewise, typical attack to a depth of 1/16-inch in three weeks was developed in laboratory tests with a complete full size engine such as used in river barge service.

The next occurrences investigated were in very large Diesels on ocean-going ships. Subsequently,

---

★ A paper presented at the Sixth Annual Conference, National Association of Corrosion Engineers, St. Louis, Mo., April 4-7, 1950.

* Corrosion Consultant, Pittsburgh, Pa.

** In charge, Corrosion Engineering Section, Development and Research Division, The International Nickel Co., Inc., New York, N. Y.

*** Corrosion occurs also as a major factor in cylinder wear on the piston side, but this cause of cylinder deterioration will not be considered in this paper. Those interested should refer to C. G. Williams and W. M. Duff, J. Inst. Auto. Eng. (London) pp. 73-92 (1933) June.

the same type of attack was observed in railroad Diesels, in Diesels used to tow barges on inland waterways, and in truck Diesels operating on the highways. Similar attack has been reported on cylinders of gas engines used in pumping or compressor stations on cross country gas pipe lines.

Figure 1A—Pattern of attack developed in early stages of erosion of Diesel engine cylinder liner. (Photo courtesy Dravo Corp., Pittsburgh, Pa.)

The nature of the attack is illustrated by Figures 1 to 3. It is characterized by the following features:

1. The corroded metal has a honeycombed appearance.
2. The corroded surfaces remain substantially free of corrosion products.
3. The attack occurs in sharply defined areas with the boundary between the affected and unaffected metal being very sharp and abrupt, though usually irregular in outline.
4. The center lines of the areas of greatest attack are characteristically 90° from the center line of the crankshaft. Attack on one side is usually more severe than on the other. Occasionally, there is faint attack of the same nature in the fore and aft quadrants in line with the crankshaft. Frequently, attack is much deeper towards the bottom—the looser end of the liner, and is often absent in the center portion but may appear to a lesser degree near the top, as shown in Figures 1A and 1B.
5. The location of this particular kind of attack does not seem to be determined to any primary extent by the location of the water inlet and outlet passages, nor by so-called "hot spots." However, there have been instances of cylinder liner erosion that have been connected with the location of water passages and regions of unusually high velocity and turbulence and which have been eliminated, or reduced, by improvements in the water flow arrangements.
6. The rate of attack has been amazingly high, e.g. 5/16-inch in 900 hours which is equivalent to about 3 inches per year. In terms of equivalent electric current, the corresponding anodic current density is 5940 milliamperes per square foot—which is enough to eliminate any casually encountered galvanic or stray currents as a likely source of the corrosion. The indicated rate of corrosion in terms of weight loss is about 16,000 milligrams per square decimeter per day. Assuming an oxygen depolarization type of corrosion reaction, the rate of oxygen consumption would be 1275 cc. (STP) per square foot per hour. Furthermore, about 64 gallons of water saturated with air at 86° F would be required per hour to furnish the required amount of oxygen per square foot of corroding surface. Assuming an unlikely hydrogen evolution corrosion reaction, especially in waters having a pH over 8.5 in which attack has been observed, the equivalent rate of hydrogen generation would be 2550 cc. (STP) per square foot of corroded surface per hour. These figures obviously take the form of damage out of the class of any ordinary corrosion of iron by hot water.
7. This peculiar attack is not confined to any one design or make of engine. It may appear in only a few engines of a particular type and sometimes only in certain cylinders of one engine.

This evidence that the peculiar attack shown in Figures 1 to 3 is not ordinary corrosion made the similarity of the form of attack to that observed in certain cavitation-erosion tests especially significant.

One method of studying the resistance of materials to cavitation-erosion is to attach test specimens to a vertical carrier partially immersed in a test liquid. The specimen carrier is a nickel tube which forms the core of a high frequency magnetic circuit. Nickel has the property of changing its length when magnetized so that acting as the core of the magnetic circuit it develops a high frequency longitudinal vibration. The magnetic circuit is tuned to the natural frequency of the test assembly and may be of the order of 6,000-9,000 cycles per second. The attached test specimen also, of course, vibrates at the same frequency through an amplitude of the order of 0.003 inch.

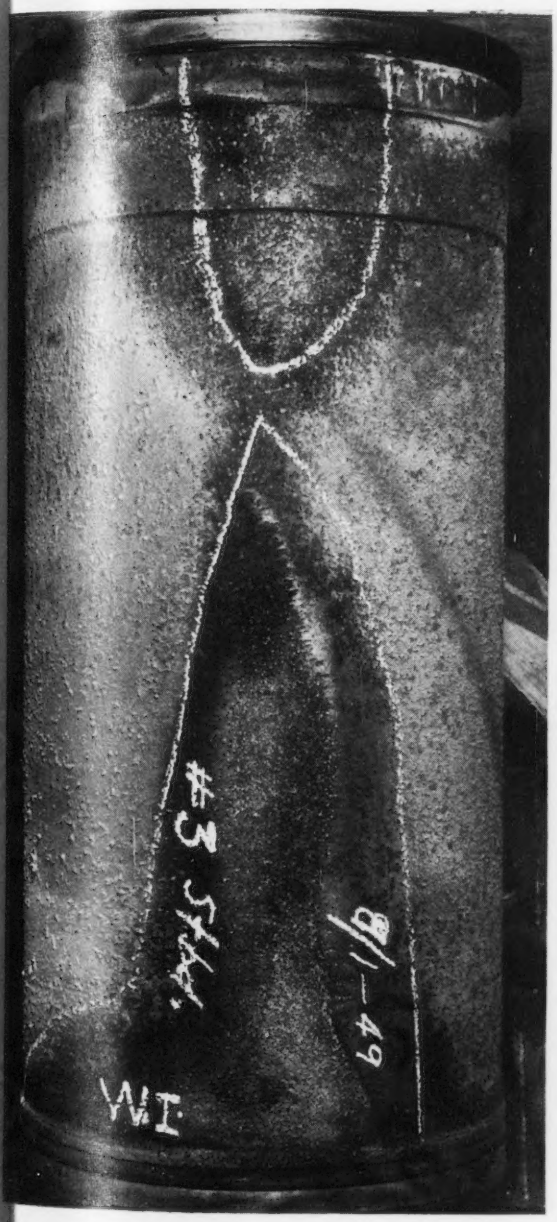


Figure 1B—Progression of attack during later stages of deterioration of liner shown in Figure 1A. (Photo courtesy Dravo Corp., Pittsburgh, Pa.)

One of the results of this high frequency vibration is to cause cavitation in the test liquid and cavitation-erosion of the surface of the test specimen due to the collapse of the "vacuum" bubbles on the vibrating surface.

This method of test has been used by several investigators.[1,2,3]

The similarity between the attack on cast iron specimens in this type of vibratory cavitation-erosion test and the attack that sometimes occurs on

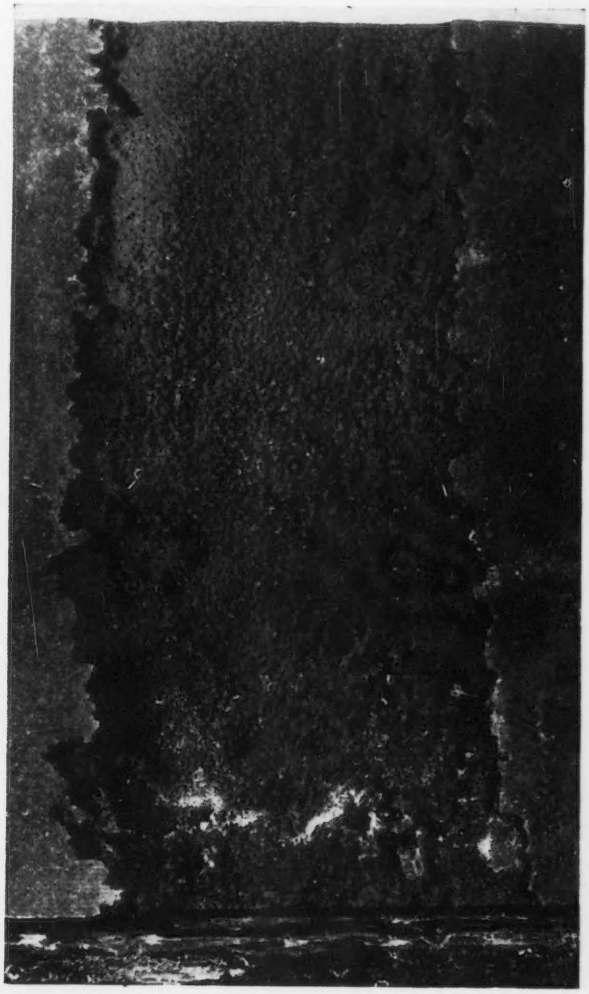
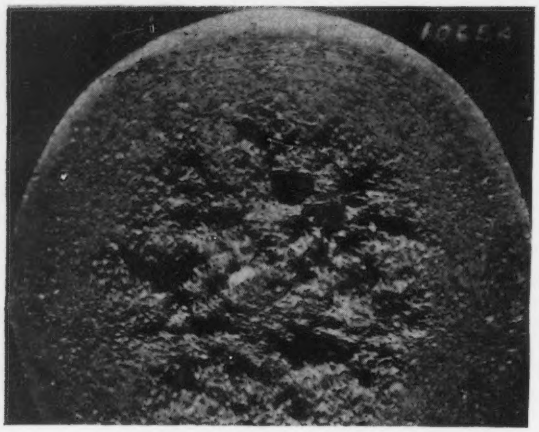


Figure 2—Erosion of water side of large Diesel engine which progressed to perforation of cylinder wall.

Figure 3—Cross section of Diesel cylinder showing erosion from the water side.



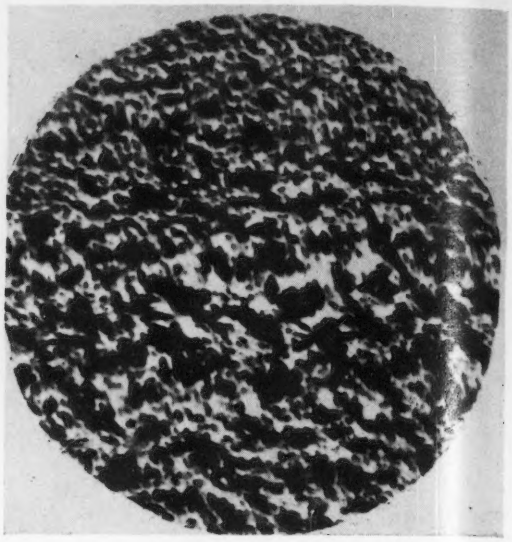


Figure 4—Comparison of a specimen of cast iron after vibratory cavitation erosion test (left) with section of affected area of Diesel cylinder shown in Figure 1 (right).

the water side of Diesel engine cylinder liners is striking as shown by Figure 4 in which a photograph of a specimen of cast iron after test in water in a vibratory test apparatus operated by Kerr[1] has been placed in juxtaposition to a photograph of a section of the attacked area of the Diesel liner in Figure 1 which had suffered attack of the type under discussion. Included also for comparison is a photograph of cavitation-erosion of the trailing side of a steel hydraulic turbine blade—Figure 5.

Because this sort of attack can be made to occur readily on cast iron by causing it to vibrate in contact with water, it is reasonable to assume that when what appears to be an identical form of attack has occurred on cast iron Diesel liners in contact with water, vibration of the liners may reasonably have been a major factor in the occurrence. This assumption is supported further by surveys of vibration in engines that have suffered this type of liner attack. In spite of the difficulties in making a proper study of the vibration of the critical surfaces, a considerable amount of high frequency vibration of the liners has been detected with observed frequencies of the order of 1500 cycles per second.

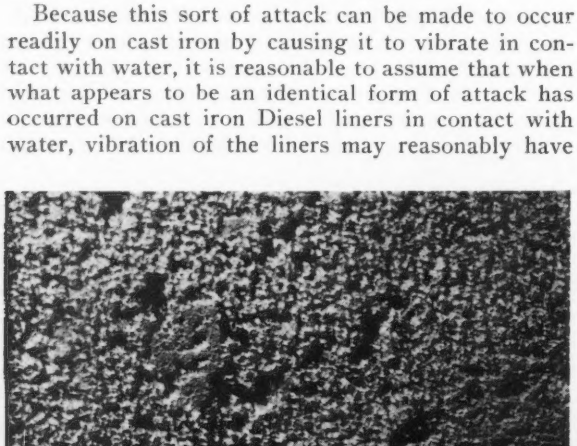


Figure 5—Cavitation-erosion of steel in hydraulic turbine (photo courtesy of P. M. Hess).

A major difference between the attack that occurs in the laboratory vibratory cavitation-erosion testing apparatus and that which occurs in engines is the rate of attack. The attack of the specimen shown in Figure 4 occurred in 90 minutes, while that of the cylinder liner in the same figure required several hundred hours.

Cavitation-erosion is a complex phenomenon which includes simple mechanical damage from the pounding effects of the collapsing vacuum bubbles plus chemical or electrochemical action of the liquid involved. Some consider the mechanical effect to be all important, while others believe that the action is principally chemical or electrochemical, with the principal effects of the mechanical action being to prevent any protective film formation or polarization of the corroding surfaces,[4] thus maintaining attack at an extremely high initial or instantaneous rate. The truth probably is between these extreme points of view, with either mechanical or corrosion effects predominating, depending on the severity of the cavitation effects, as reflected in the time in which the action occurs, the nature of the material and the corrosivity of the environment.

That ordinary electrochemical corrosion is not necessary is demonstrated by the occurrence of cavitation-erosion on non-metals like glass. That mechanical effects are not always of controlling importance is shown by the extent to which cavitation-erosion can be suppressed by the application of cathodic protection to test specimens,[5] and by the

generally superior performance of corrosion resisting metals and alloys.

As indicated previously, the commonly used laboratory vibratory cavitation-erosion test method tends to accentuate the mechanical factors relative to the corrosion factors—as indicated by the fact that so much damage is accomplished in such a short period of time. It is not surprising, therefore, that the laboratory test method does not more definitely disclose effects of variations in the corrosion resistance of the materials tested nor differences in the corrosivity of the test liquids. This latter point was illustrated particularly well by the recent work of Rheingans[3] who reported no more cavitation-erosion of steel by sulfuric acid than by ordinary water in his vibratory cavitation-erosion testing apparatus. Nevertheless, these accelerated test methods regularly show considerable value of high resistance to corrosion by rating corrosion resisting metals and alloys above ordinary iron or steel having equal or better mechanical properties. They thus point at least indirectly to the role of corrosion in cavitation-erosion.

From the practical standpoint, the fact that corrosion is a major factor is very important, because, in many cases, it is easier to do something about corrosion than to improve the mechanical factors—e.g. as by eliminating or reducing vibration.

In the case of the Diesel liner problem of cavitation-erosion which the authors feel can be described properly as such, there are two avenues of attack from the standpoint of corrosion.

The most common approach has been to reduce the corrosivity of the cooling water by control of alkalinity and the addition of chromate inhibitors. This practice was described by Hanson[6] who has reported this trouble to be under control by carefully maintained chromate treatment in railroad Diesels. The effectiveness of chromate inhibitors suggests that corrosion frequently, if not always, predominates over mechanical forces in the cavitation-erosion of Diesel engine cylinders.

It would not be expected that chromate or other inhibitors would be particularly effective in preventing cavitation-erosion where mechanical factors predominate as they do in the laboratory vibratory tests. This was confirmed by tests made for the authors by William J. Rheingans of Allis-Chalmers and reported in his ASME paper.[3] The object was to discover in the Allis-Chalmers test setup whether chromate additions to the water would eliminate or reduce cavitation-erosion of cast iron, including the alloy iron regularly used for Diesel cylinders. For convenient reference, these results are summarized here in Table I.

It will be observed that only in the case of the alloy cast iron liner material hardened by heat treatment was the addition of the chromate effective in reducing attack. Otherwise, the principal indication was that resistance to attack was a direct function of hardness—as might be expected where the mechanical forces were in control. The better response of the heat treated alloy cast iron to chromate inhibition shown in these tests was in line with its general superiority over plain cast iron in service.

The nature of the attack of ordinary iron in water with and without chromate treatment and the improvement in the presence of chromate with the heat treated alloy iron are shown by the photographs of test specimens in Figure 6.

The Allis-Chalmers tests failed to to demonstrate the merit of the corrosion resistant austenitic cast iron Ni-Resist* which in these tests performed, probably because of its low hardness, no better than plain iron and did not respond to the protective effect of chromate inhibitor.

Just as the chromate inhibitors are more effective in practice than in the laboratory vibration tests, so the austenitic cast irons have performed much better

* Registered, U. S. Patent Office.

TABLE I

Summary of Results of Cavitation-Erosion Tests of Different Irons in Water With and Without Chromate Additions*

MATERIAL	Condition	Hardness Rockwell A	Loss in Weight in Milligrams in 120 Minutes in Cavitation-Erosion Test		
			Distilled Water	Water + 2000 PPM Chromate pH 8.6	Water + 4000 PPM Chromate pH 8.6
Nickel Chromium Cast Iron...	As Cast	55	68	67	67
Nickel Chromium Cast Iron...	Heat Treated	71	59	36	31
Ni-Resist, Type 1[2].....	As Cast	43	136	115	122
Ni-Resist, Type 2[3].....	As Cast	35	166	166	181
Ni-Resist, Type 3[4].....	As Cast	42	133	130	115

Chemical Composition—%

	Tc	Si	Mn	Ni	Cr	Cu	P	S
1.....	3.15	2.14	0.64	2.17	....	....	0.08	0.08
2.....	2.97	1.82	1.21	13.82	2.24	6.14	0.08	0.08
3.....	2.74	2.32	1.20	19.98	2.00	....	0.08	0.08
4.....	2.47	1.81	0.71	29.75	3.00	....	0.08	0.08

* Data from Rheingans[3].

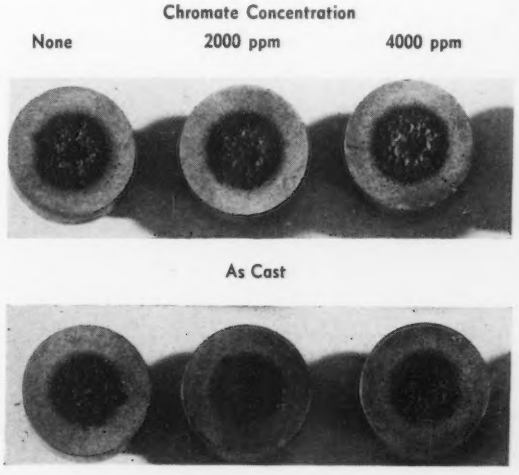


Figure 6—Specimens of 2 percent Ni cast iron after vibratory cavitation erosion test.

in service than in the laboratory. Ni-Resist liners are in common use—especially in truck Diesels on the West Coast—as a means of overcoming severe water side attack of the cavitation-erosion type, as well as providing improved resistance to corrosive wear on the piston side. The Ni-Resist liners generally show only superficial pitting after use for 90,000 miles, whereas cast iron liners are often pitted severely after 35,000 miles.

Attempts have been made to arrest the peculiar cavitation-erosion attack of Diesel liners by the application of protective coatings, including baked phenolics. These have not performed well and have failed within three months by a process that was described as "blasting off" in the areas subject to attack, followed by the immediate incidence of pitting of the bright metal exposed. These would be natural consequences of vibratory effects of the type believed to be operating.

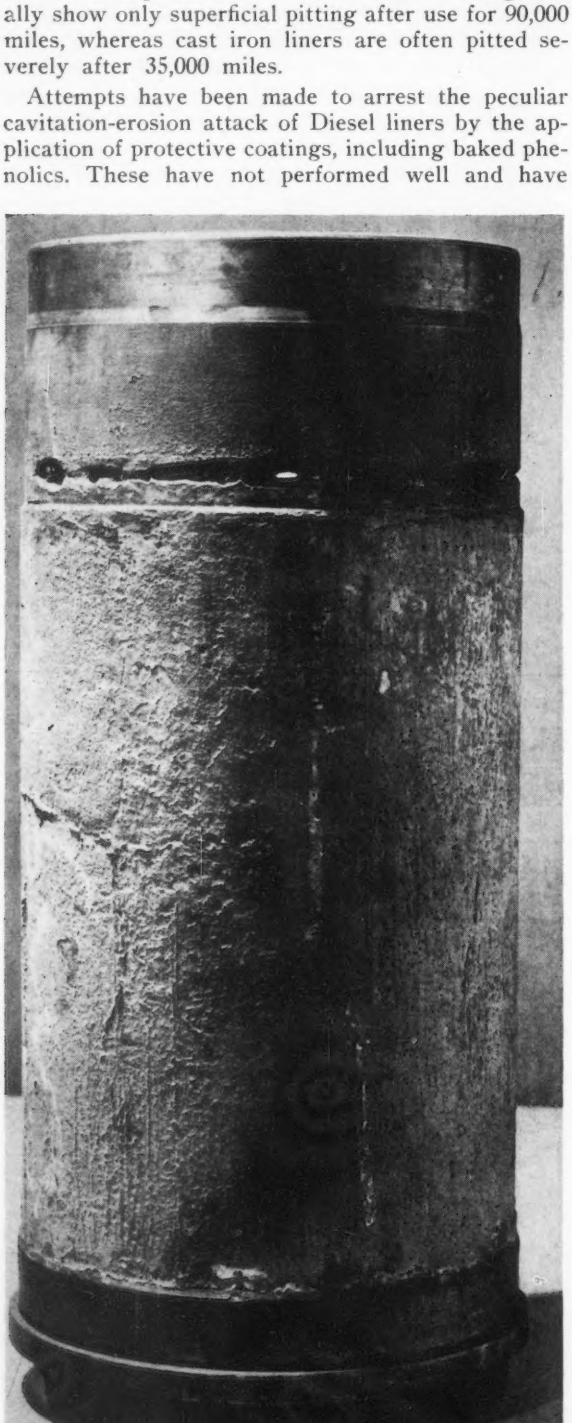


Figure 7—Crevice corrosion of Diesel cylinder liner under rubber sealing gasket.

On the basis of practical experience and the conception of the problem as one involving cavitation-erosion, as well as any ordinary corrosion, one or more of the following steps may be expected to provide effective remedies of the diffculty:

1. Reduce vibration of the liners by any practical means, as by redesigning the liner supports to introduce damping effects or avoid opportunities for resonant vibrations at natural frequencies to become established.
2. Develop and use more resistant liner metal. Hardened alloy cast iron liners appear to respond better than soft plain cast iron to chromate inhibition of corrosion.
3. Treat the water with chromates in proper concentration e.g. 2000 ppm or more and adjust pH to proper value, e.g. 8.5 to 9.5. Begin this immediately when the engine is put into service and maintain it thoroughly, because once attack has started, it may be difficult to arrest it. If attack has started, add suitable wetting agents which will not have a reducing effect on the chromate as determined by preliminary studies.
4. Reduce the opportunity for vacuum cavities to be developed by:
   a. Keeping the water temperature as high as practical.
   b. Keeping the water pressure as high as possible.
   c. Introducing air bubbles to serve as cushions against vacuum bubble collapse—as is done with hydraulic turbines. This will, of course, require simultaneous use of chromate inhibitor.

On the basis of the authors' observations as described here, it is suggested that the ultimate solution to this peculiar corrosion problem will require the cooperation of the mechanical engineers with attention to mechanical features of the design and construction of engines. More thorough surveys of high frequency vibrations will be required before they can be eliminated by changes in design that probably need be only minor in nature. Such surveys can be made most effectively on engines operated under normal load conditions and fitted with devices for the detection of high frequency vibration of the cylinder liners.

The most economical solution of widespread problems of this kind is likely to proceed from well organized cooperative research—such as was the case with the effective work on the problem of cracking of steam boilers. The authors recommend that this method of attack be considered carefully by those most interested in improving the serviceability of Diesel engine cylinder liners.

Ordinary Corrosion

It may be noted that where the peculiar kind of

orrosion which the authors have ascribed to vi-ratory cavitation-erosion does not occur, the con-rol of ordinary corrosion and tuberculation in Diesel ooling systems is not difficult. All that is required s the use of water of good quality, low in dissolved olids and treated with an inhibitor such as sodium hromate and caustic soda to pH of 8.5 to 9.5. About 00 ppm of sodium chromate will usually be suffi-ient, but it is common practice to run on the safe ide and keep the chromate concentration above 000 ppm as described by Hanson[6]—or even as high s 5000 ppm where salt water is used for cooling. In ooling water systems which include aluminum sur-aces in contact with the water it has been suggested hat the pH be reduced to something of the order f 7.0 and certain proprietary inhibtors have been eveloped to provide protection to both iron and luminum at this pH level.

Where proper treatment of the water has been elayed so that some corrosion scale has formed, a etting agent (compatible with the inhibitor) can e used to advantage to aid diffusion of the inhibited ater to the metal surfaces.

Crevice Corrosion

In addition to the peculiar corrosion identified as avitation-erosion as just described, there are occa-ional occurrences of severe crevice corrosion in ay of liner supports and especially under the rubber askets used to seal the water passages at the bot-oms of liners. Attack of this sort is illustrated by igure 7.

The mechanism of this attack is believed to in-olve differential aeration or oxygen concentration ell effects with the iron within the crevice or under he gasket being anodic to the freely exposed iron.

This corrosion is very difficult to arrest by the se of passivating inhibitors of the chromate type, ecause these won't reach the iron within the crevice that requires protection. They may even aggravate the attack by their passivating effect on the freely exposed iron and by acting as depolarizers of the cathodic surfaces.

The most likely remedies would be to apply a protective coating to the iron within the crevices or to use a plastic sealing compound, such as low melting point asphalt, that would survive exposure to the hot water for long periods and that would be heavy enough not to be floated away.

Occasionally, also, there is some galvanic corrosion of cast iron jackets which are undercut around copper gaskets, such as are sometimes used at the tops of liners. Such galvanic action can be prevented by maintaining a proper concentration of chromate inhibitor.

Acknowledgment

The authors acknowledge the help of William J. Rheingans of the Allis-Chalmers Company, Milwaukee, Wisconsin, for his help in carrying out the tests to show effects of chromate inhibitors in his vibratory cavitation-erosion testing apparatus.

References

1. S. L. Kerr, "Determination of the Relative Resistance to Cavitation-Erosion by the Vibratory Method." *The American Society of Mechanical Engineers,* **59,** No. 5 (1937) July.
2. R. Beeching, "The Resistance to Cavitation-Erosion of Propeller Alloys." *Transactions of the Institution of Engineers and Shipbuilders in Scotland,* 1946.
3. William J. Rheingans, "Accelerated Cavitation Research." *The American Society of Mechanical Engineers.* (Paper presented November 29, 1949).
4. G. Schmid and L. Ehret. *Zeis, Elektro,* **43,** p. 408, 1937. Also W. T. Richards, *Review of Modern Physics,* **11,** No. 1, 36-64 (1939) Jan.
5. G. Petracchi, "Investigation of Cavitation-Erosion." *La Metallurgia Italiana,* **41,** No. 1 (1949) Jan.-Feb.
6. M. A. Hanson, "Water Problems in Diesel Locomotives." *J. AWWA,* **40,** No. 9 (1948). Also Bulletin 469, Am. Railway Eng. Assoc., p. 80-87, Nov., 1949.

DISCUSSIONS ARE INVITED

Readers who wish to submit written information additive to articles published in CORROSION, or who wish to register differences of opinion with respect to any articles are urged to send such discussions to Dr. F. N. Alquist, Chairman, NACE Editorial Review Committee, Organic Research Laboratories, 20A Building, Dow Chemical Co., Midland, Mich. Doctor Alquist will submit such discussions to a member of the review committee, and after review and approval the discussion will be published.

The expression of opinions about or the addition of information to that contained in technical articles will advance the interests of NACE and make CORROSION more valuable to the membership.

Cathodic Protection Of Fourteen Offshore Drilling Platforms*

By E. P. DOREMUS* and G. L. DOREMUS*

Abstract

Over one-half million square feet of submerged bare steel surfaces on fourteen drilling platforms and four accompanying LST drilling tenders in the Gulf of Mexico have been placed under cathodic protection with magnesium anodes during the past fifteen months. Present practice is to use a high current density of short duration furnished by magnesium ribbon (Galvo-line) to deposit a calcareous coating on the surfaces to be protected. This polarization treatment effectively reduces current requirements for protection to a value approaching three milliamperes per square foot, and therefore a relatively small "permanent" installation of 51-lb. magnesium anodes serves to maintain both the coating and protective potentials upon dissolution of the Galvo-line. In general, a sufficient number of anodes is installed to provide protective potentials of —0.78 v minimum, referred to a saturated calomel electrode adjacent to the surface being tested, with anode outputs uniformly adjusted to project a life of two to three years for the protective system. Methods of installing the magnesium anodes and Galvo-line are discussed and illustrated. Current and potential data obtained during the course of a typical installation are presented, and experiences and results obtained during installations on several different types of structures are discussed. In an effort to obtain on-location data showing the differences in corrosion rates for protected and unprotected steel pilings in the splash, tidal and sub-tidal zones, corrosion test racks have been mounted on one cathodically protected producing platform off the Louisiana coast.

Introduction

OFFSHORE EXPLORATION and drilling in the Gulf of Mexico has been one of the most interesting and promising developments in the petroleum industry during the past several years. By far the greatest activity to date has been off the Louisiana coast, in waters varying from 10 to 50 feet in depth. Structures capable of supporting heavy drilling equipment and withstanding the destructive forces of the sea, including occasional hurricanes, were essential to the offshore program and presented knotty problems to the design engineers.

Two distinct types of drilling platforms have evolved to date. One of these is the template type, in which a jacket consisting of vertical pipe sections adequately cross-braced is prefabricated on shore and floated to location. After the jacket is lowered into position on the Gulf floor, the vertical pipe members serve as guides for slightly smaller pipe piles, which are driven through them to penetrations varying from seventy to two hundred and fifty feet. A typical platform of this construction is shown in Figure 1.

The second type of platform consists simply of a relatively small number of large pipe piles, usually 26-inch to 30-inch in diameter, driven into the mud to suitable depth and cross-braced with structural members above the water line. In certain instances additional cross-bracing by means of stranded galvanized cables, some of which may be anchored to "deadmen," is utilized. A structure of this type is the 6-pile platform shown in Figure 2.

The size of these platforms depends principally on whether they are used in conjunction with floating barge tenders, in which case only the derrick and draw works are mounted on the platform, or whether they function as complete operational units, with living quarters, mud tanks, pipe racks and supplies also located on the platform itself. The present trend is toward the former method of operation, and many converted LST and YF barges are in use today as drilling tenders. Platform size is also governed by the number of wells to be drilled, which may run as high as ten per platform.

The corrosion problem on these structures is obviously a major one. In particular, where production is obtained and the platform is to remain in service for many years, the need for adequate protection both above and below the water line becomes of primary importance.

Test installations at Kure Beach, North Carolina, have shown that corrosion of steel piling in sea water proceeds most rapidly in the splash and spray zone,[1] as might be expected. Fortunately, protective paint coatings have been developed which give satisfactory results on all surfaces above the tidal zone. Corrosion of the submerged piling surfaces, although less severe than in the splash zone, is still quite serious, and the performance of paint and bituminous coatings on such surfaces has not been as satisfactory. Failure of coatings below the water line is accelerated by the growth of marine organisms, and effective coating life probably rarely exceeds three years. Recently published data showing the actual corrosion rates for bare electrically coupled mild steel plates in sea water, simulating a continuous pile, are presented in Figure 3. The effect of the galvanic current flow from the anodic zone just below low tide to the cathodic tidal zone is clearly visible; the corrosion rate in the anodic zone approaches nine mils per year. These data indicate a second anodic zone just above the mud line, where the rate of attack exceeded seven mils per year. It is readily apparent that underwater corrosion will

★ A paper presented at the Sixth Annual Conference, National Association of Corrosion Engineers, St. Louis, Mo., April 4-7, 1950.

* Cathodic Protection Service, Houston, Texas.

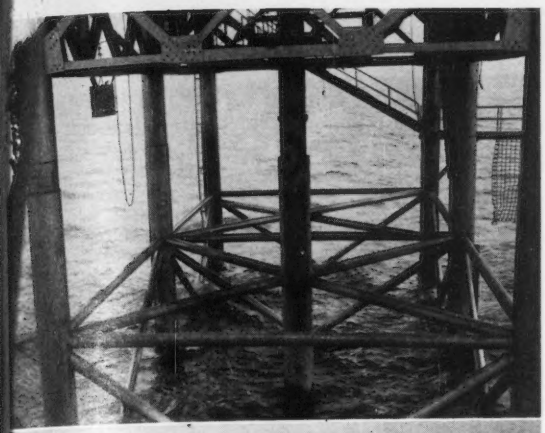


Figure 1—Offshore platform of template construction.

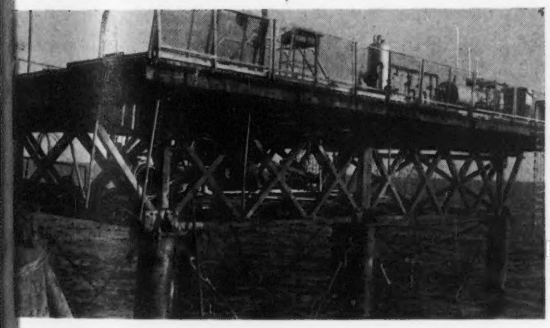


Figure 2—Offshore platform of large pile construction.

proceed rapidly after a brief delaying action by coatings, if any, and lead to serious weakening of the structure during its normally anticipated operating life.

An actual example of the corrosive attack on platform jacket which had been in service approximately two years before removal is presented in Figure 4. The member shown is a horizontal brace just above the mud line; it had been sand blasted and primed before the picture was taken. The deepest penetration found before sand blasting was 0.13 inches. Relatively little attack occurred below the mud line and in the region immediately below the tidal zone. It is believed that the seriously corroded surfaces just above the mud line were anodic to the considerable area of metal lying in the mud, while periodic painting of the upper portion of the jacket reduced the exposed area in the highly cathodic tidal

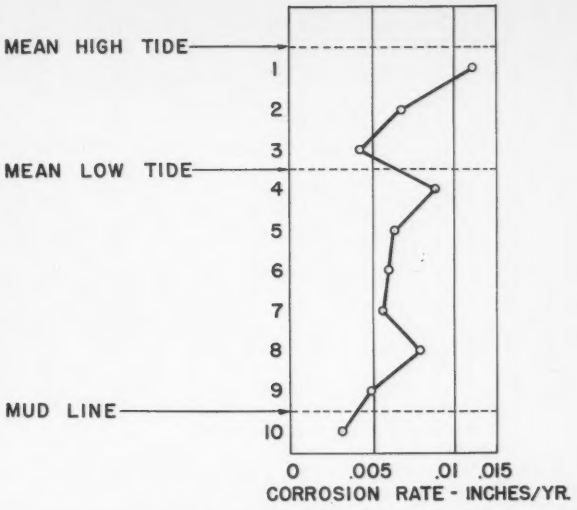


Figure 3—Corrosion rates of coupled mild steel plates exposed to sea water six months. (The Dow Chemical Co.)

Figure 4—Corrosion on platform jacket after two years' exposure in Gulf waters.

zone and thereby limited the rate of attack on those surfaces lying immediately below.

Fortunately, it has been shown experimentally that corrosion of submerged steel surfaces in sea water, which cannot effectively be protected with coatings for any appreciable length of time, can be practically eliminated by cathodic protection and that such protection also reduces the rate of attack on steel piling in the tidal zone.[1,2]

It is the purpose of the present paper to discuss the successful application during the past 15 months of these experimental data to the cathodic protection of over one-half million square feet of submerged steel surfaces on fourteen offshore platforms and four LST drilling tenders in the Gulf of Mexico. Ten of these platforms were of the jacket type and the balance were of the large piling type. Total submerged area per structure ranged from 16,320 to 86,070 square feet.

Factors Governing Design

In the excellent investigations referred to above,

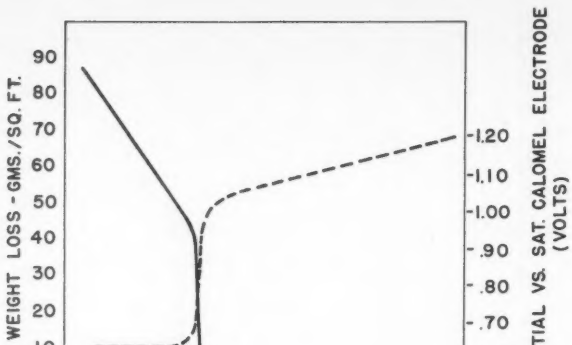


Figure 5—Weight loss and potential of coated plates versus applied current density after one-year exposure in sea water. (The Dow Chemical Co.)

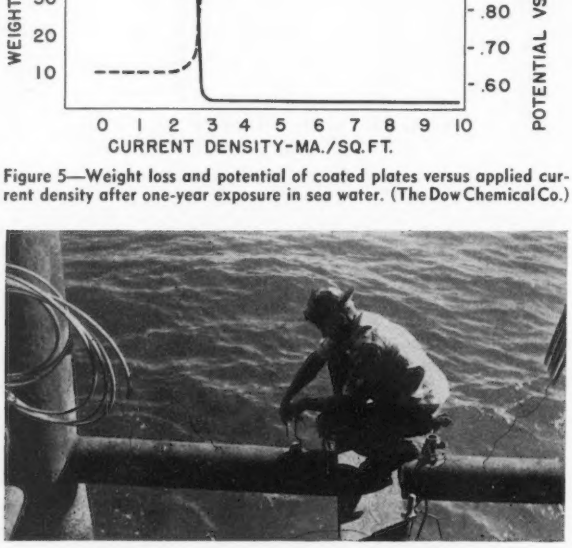


Figure 6—Brazing Galvo-line leads to platform using Cadweld equipment.

production of protective potentials of -0.78 volts, referred to a saturated calomel electrode, on bare steel in sea water initially required in excess of 10 MA/sq. ft., although protection was eventually achieved with 6 MA/sq. ft. It was further shown that immediate protection was obtained by applying 50 MA/sq. ft. for five days, thus polarizing the structure and laying down a calcareous coating on the steel surfaces, and that protective potentials and coating both could then be maintained at a current density as low as 3 MA/sq. ft. Figure 5 shows the very interesting and important weight loss—current density—potential relationship for coated steel plates immersed in sea water for one year at Kure Beach, North Carolina.

The use of the high current density polarization treatment, frequently referred to as the Cox marine electrocoating process, to stabilize current requirements with respect to time can be shown by simple calculation to result in ampere-hour savings of 40% during the first year of protection. Even though this technique is patented[3] and involves a small license fee for commercial application, this fee and the additional expense of the polarizing installation itself were both considered economically justified by the savings in ampere-hours and hence in the size of the permanent installation, as well as by achievement of immediate protection.

It is appropriate that credit be given here to Sir Humphry Davy[4] for observing first, in 1824, that calcareous deposits were formed on the cathodes of galvanic couples immersed in sea water. In experimental work dating from 1935 Colonel G. C. Cox and associates have made a thorough investigation of the characteristics of such coatings developed over a very wide range of current densities. In the course of these studies a number of practical demonstrations of the effectiveness of high current densities both for descaling and for coating were carried out during the war years, utilizing motor-generators as source of current in most cases.

For electrocoating purposes it has been found that current densities from 50 to 350 MA/sq. ft. give quite satisfactory results, although the most dense, and hence the most desirable, coatings have been formed at 100 to 200 MA/sq. ft.[5] Such coatings contain approximately equal parts of calcium and magnesium, in the form of the carbonate and hydroxide, respectively. For optimum results total current at high densities should fall in the range of 6 to 10 ampere-hours/sq. ft.

With the decision made to utilize the electrocoating approach, the next step was to select practical and economical current sources for both high and low current density functions. Since there has been no electrification of offshore producing fields to date, no cheap source of AC for rectifier operation was available. Motor generators and wind-driven generators, in combination with graphite anodes, presented possibilities, but maintenance is a well-recognized problem with such equipment, one which would be accentuated under offshore operating conditions. The remaining alternative, sacrificial galvanic anodes, appeared to be the most practical answer, particularly since high-purity magnesium anodes were commercially available in two forms which were ideally suited to the separate processes of electrocoating and maintenance, or cathodic protection. High-purity magnesium and magnesium alloy anodes develop 0.7-0.8 volts against a steel structure polarized to protective potential referred to a saturated calomel electrode, of —0.78 volts. It is important that these net driving potentials are sufficient to produce the necessary current densities for both processes with installations of reasonable size.

An extruded cored ribbon of cell magnesium, with dimensions ⅜-inch x ¾-inch, was selected to provide the high current density of short duration for electrocoating purposes. This material (proprietary name, Galvo-line), when installed in moderate lengths, can be expected to deliver 0.5 amperes or better per lineal foot against an unpolarized structure in sea water. Galvo-line weighs 0.22 pounds per foot and is nominally rated at 100 ampere-hours per foot. It will therefore have a life expectancy of eight days, approximately, when delivering 0.5 amperes per foot. At this output the necessary minimum current density of 50 MA/sq. ft. will be obtained by installation of a total length of material equal to one-tenth of the area in square feet of the surface to be polarized.

For the more permanent part of the installation, which would be required to furnish 3 MA/sq. ft. of platform surface after polarization, a 51-pound high-

purity magnesium alloy anode with ⅜-inch centrally cast pipe core was selected. It appeared desirable for several reasons to limit design life in the case of original installations to two years, and the 51-pound anode is nominally so rated when delivering 1.8 amperes, corresponding to a metal efficiency of 60%. Hence one anode can be expected to provide protective current for each 600 square feet of surface for a period of two years.

To illustrate the use of both materials in cathodic protection design, a platform with a total submerged surface of 30,000 square feet would require some 3000 feet of magnesium Galvo-line operating at unrestricted output and 50 of the 51-pound anodes with output limited to 1.8 amperes each. Assuming 0.5 amperes per foot of ribbon, this amount of this material would provide a total of 1500 amperes for polarization, while a total of 90 amperes would be delivered by the anode installation for the design life of two years.

For purposes of design all steel below the mud line has been assumed to have the same requirements as that in the sea water, although it was recognized that such could not be the case. This was done in the absence of more specific information in order to leave the design on the conservative side. The effect that this has had on the results obtained in practice will be discussed later.

Installation Techniques and General Procedure

Reliable and economical methods of installing these forms of magnesium on offshore structures were obviously essential to the successful application and acceptance of cathodic protection in this new field. Present installation techniques, which are believed to fulfill the requirements of simplicity, economy and overall satisfactory performance, will be reviewed briefly.

Considering first the polarization installation, the basic problem was that of attaching a large number of 20-30-foot lengths of Galvo-line to the structure to be protected in such a manner as to insure good electrical contact during the brief life of the Galvo-line.

Two methods have been used to attach copper lead wires of various sizes to the Galvo-line strips. One of these is to expose a short length of the No. 13 iron wire core for a soldered connection; the other, which is less time-consuming and equally satisfactory, is to make a simple mechanical connection which is protected with some form of dope to prevent loss of contact by excessive local action. The other end of the copper lead wire is usually brazed to any convenient platform member to complete the circuit. The use of Cadweld brazing equipment for this purpose is illustrated in Figure 6.

The importance of holding Galvo-line lead resistance to a reasonably low value is illustrated by the curves shown in Figure 7. These curves represent actual data obtained in measuring Galvo-line output against a large unpolarized platform in thirty feet of water. The lead resistance associated with the upper curve (0.0075 ohms) corresponds to five

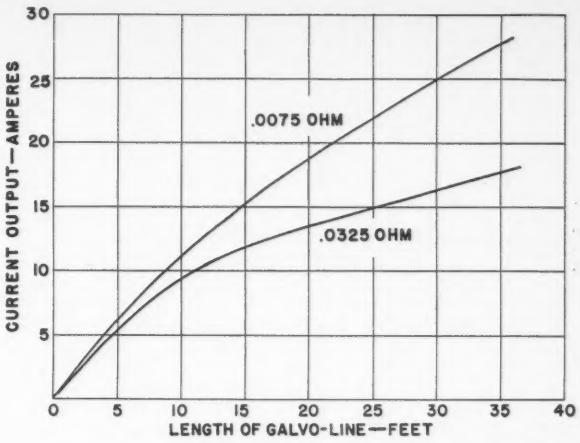


Figure 7—Effect of lead resistance on output of Galvo-line against unpolarized steel in sea water.

feet of No. 12 copper wire, this length being the practical lower limit for Galvo-line leads. The resistance associated with the lower curve (0.0325 ohms) corresponds to approximately twenty-two feet of No. 12 wire, which is the longest lead apt to be required. The effect of 0.025 ohms added resistance is seen to amount to a reduction in output of seven amperes, or 32%, for a twenty-five-foot length of Galvo-line under these conditions.

This effect will be less serious against a polarized structure at —1.00 to —1.10 volts due to the overshadowing effect of reduced net driving potential, but it is still a factor to be considered in design. Since it is scarcely practical to salvage Galvo-line leads, economy dictates use of the smallest size wire compatible with the above data. As a general rule No. 12 copper wire is satisfactory for lead lengths up to eight feet, while for longer leads No. 10 or No. 8 wire should be used.

These curves also serve to illustrate the fact that Galvo-line in sea water will deliver at least 0.5 amperes per foot in moderate lengths against an unpolarized structure, as previously represented. In this connection it is worthy of note that the mutual interference effect between Galvo-line strings is relatively slight in highly conductive sea water; in one case where sufficient data were obtained it was computed to have caused no more than a 10% reduction in total Galvo-line output.

A new method of attaching Galvo-line which appears to offer the best solution to the problem has been employed in very recent installations. It involves pinning one end of a suitable length of the ribbon to any convenient platform member by means of a hardened metal fastener fired from a specially designed gun. The fact that more Galvo-line per platform is required, since the Galvo-line in effect serves as its own lead, is offset by the advantage of having an extremely low resistance connection and elimination of most of the damage to protective coatings on the platforms which results from brazed connections. The unconsumed Galvo-line is not wasted, since it can be salvaged and spliced with the same gun device for use in subsequent installations.

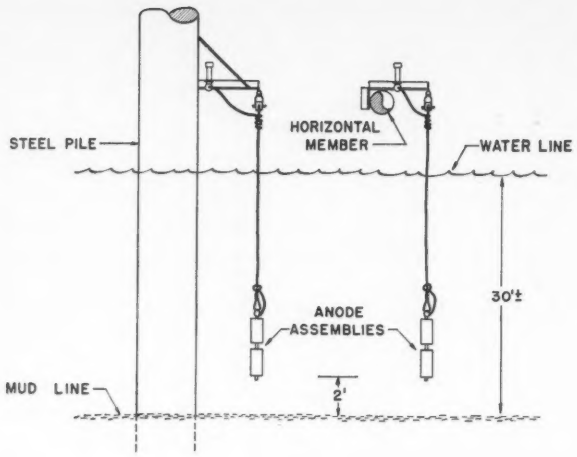


Figure 8—Typical magnesium anode suspensions on offshore drilling structures.

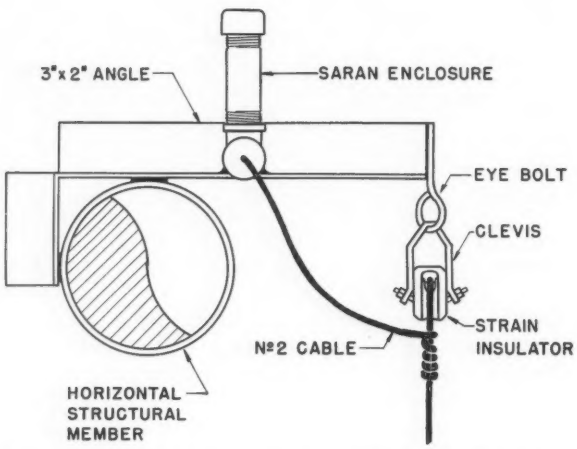


Figure 9—Angle bracket type support for magnesium anode strings.

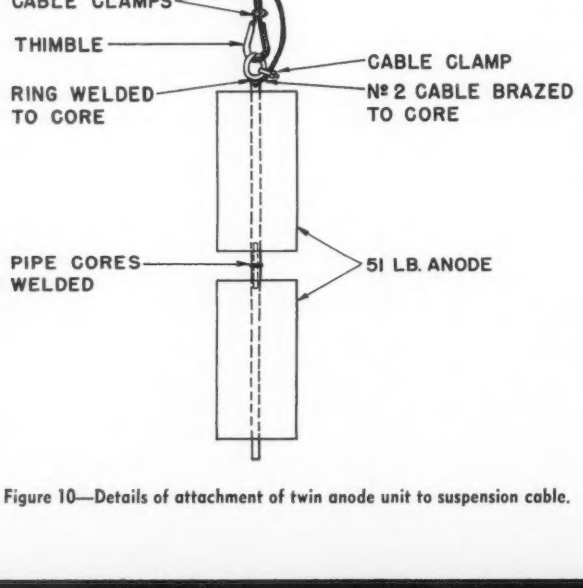


Figure 10—Details of attachment of twin anode unit to suspension cable.

Development of a simple method of installing th 51-pound magnesium anodes which would withstan wave action under the worst of normal weather con ditions, while permitting easy anode replacemen has been more of a problem. Of course, what ma happen to the platform itself under hurricane cond tions is always a matter of conjecture, and therefor whether or not the cathodic protection installatio continues to function after such a disturbance ma become a moot question. However, this does no mean that every effort has not been made to desig an installation which will survive in satisfactor manner the worst the Gulf has to offer.

It appeared likely that a free-swinging suspensio would withstand wave action better than rigid sup ports of any practical size and would also simplif anode replacement. Momentary contact betwee magnesium anodes and underwater steel surface during rough weather would result only in slightl increased anode output for the period of contac which would be of little consequence.

It was decided to suspend the magnesium anode by means of No. 2 insulated copper cables, using a strain insulator and clevis arrangement to attach th anode string to eye bolts welded to convenient ex isting structural members, or to specially fabricate supports. These were usually located five to fifte feet above the water line. In order to reduce th number of supports required, two anodes were sus pended on each string. The two anodes were welde together by means of the pipe cores to form a 102 pound unit, which was still a convenient size fo handling manually. This unit was positioned a few feet above the mud line for maximum stability an attachment to the end of the No. 2 cable was made by means of a thimble-and-ring arrangement, whic served to mimimize the effect of cable flexing a the point of attachment during rough seas. The projecting pipe cores at each end of each anode an the adjacent anode surfaces were doped to minimize possible wasteful undercutting of the magnesium along the cores.

Typical anode string suspensions are illustrated in Figure 8, while Figure 9 shows details of the upper cable attachment to an angle bracket type of sup port which has been used extensively in recent in stallations. The twin anode assembly and method o attaching it to the No. 2 suspension cable is illus trated in Figure 10. The copper cable is terminate in a simple enclosure which houses the 0.01 ohm shunt and resistance wire that are inserted in each anode string circuit for purposes of current measure ment and adjustment, respectively. Details of this enclosure are presented in Figure 11.

It has been found highly desirable to reduce work ing time on location to a minimum, and in order to accomplish this, all possible prefabrication of anode strings, supports, Galvo-line, etc., is carried out on shore. The only heavy operations ordinarily carried out offshore are distributing and attaching Galvo line, welding anode supports to the structure, and installing the strings by inserting the clevises through the eye bolts and insulators.

Actual location of anode strings about the plat

form is usually governed by estimated distribution of surfaces to be protected; perfect correlation is not essential, however. Anode strings are always kept well inside the outer row of pilings for protection against damage from crew boats and supply barges. In the case of LST tenders, all magnesium is installed within fifty feet of the bow and stern so as to leave ample space for loading and unloading operations amidships. Anode string supports on the tenders are removable so that the strings and supports may be stored in a safe place while the vessel is in motion or in dry dock.

Present procedure is to install both Galvo-line and anode strings concurrently and to leave the latter operating at unrestricted output during the polarization period in order to obtain maximum current density on the surface being treated. Random checks on Galvo-line outputs are made to allow estimation of the probable life of the polarization installation and plans are made accordingly to return for final survey and adjustment of the system. During the final survey residual Galvo-line is removed and anode string outputs are adjusted to 3.6 amperes so as to project two-year life. Piling potentials at various locations about the platform are then measured to determine whether protective potentials have been attained at all points. Usually it is possible to readjust outputs downward, thus extending the projected life of the system beyond two years, while maintaining very satisfactory potentials of —.090 volts or higher.

The electrode assembly used in measuring piling-to-sea water potentials is shown in Figure 12. The electrode proper is of the saturated calomel type and is capable of withstanding pressures up to thirty pounds. It lends itself well to measurements in sea water since it is not readily contaminated; however, it is of glass construction and must be adequately protected to prevent breakage. The enclosure provided serves this purpose and also supplies the necessary weight to assist in positioning the electrode during potential measurements. Simple calculation shows that suspending the reference electrode two inches away from a surface receiving 3 MA/sq. ft. in sea water introduces a negligible IR drop error in the reading obtained. However, measurements during polarization at high current densities include a slight IR drop error for which no correction has been made in the values reported in this paper.

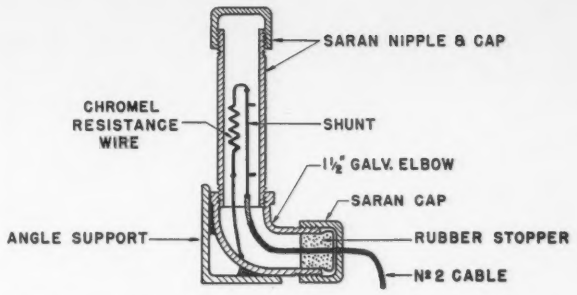


Figure 11—Details of Saran enclosure for shunt and resistance wire.

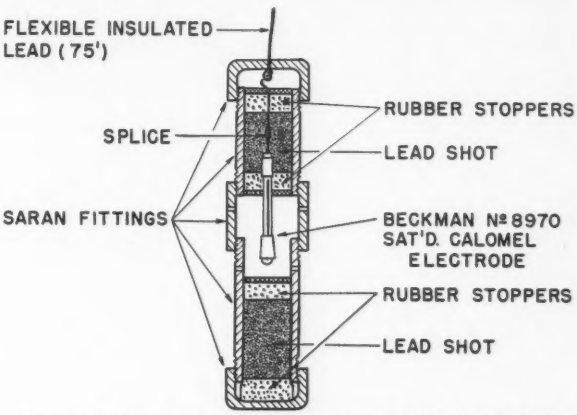


Figure 12—Calomel electrode used in measuring piling-to-sea water potentials.

Discussion

Because it would be difficult to designate any one of the fourteen completed cathodic protection installations as "typical," installation data have been summarized in Table I for three platforms of different sizes and types which serve to illustrate the kind of results which may be expected in practice. These data clearly show that the final overall current density required for maintenance of protective potentials on these platforms depends on the relative areas in the water and mud zones, with lower overall requirements where larger percentages lie in the mud zone, as would be expected. This is reflected in final adjustment of anode outputs to lower values, thus projecting longer life in such cases.

It is worthy of note that piling potentials before protection were relatively uniform, with a range of only —0.65 to —0.69 volts for the fourteen structures under discussion. A considerable lack of uniformity in potentials was observed during the early stages of polarization; however, this condition rapidly improved as the calcareous coating formed and better current distribution was obtained. Final potentials after anode adjustments rarely deviated more than ±0.05 volts from the average, with no more than 0.01-0.02 volt difference between readings at the mud line and those near the surface for any given piling. An

TABLE I

Installation Data on Three Offshore Platforms of Different Types and Sizes

Platform Type	Large Pile	Template	Large Pile
Water Depth	33′	22′	18′
Total Submerged Area (Square Feet)	16,320	26,020	27,600
Area in Water Zone Only	40%	56%	14%
Piling Potentials (Unprotected)	—0.68v	—0.68v	—0.65v
Galvo-Line Installed: (1) Total	1650′	2600′	2750′
(2) Lengths	30′	22′	25′
Anodes Installed (51 Pound)	28	42	46
Polarization Data:			
(1) Total Current (Amperes)	391	1360	590
(2) Potentials in Early Stages (Average)	—1.04v	—1.01v	—1.18v
Final Current, Adjusted:			
(1) Total Amperes	42.0	63.0	57.5
(2) Amperes/Anode	1.50	1.50	1.25
Final Piling Potentials (Average)	—0.98v	—0.97v	—0.96v
Projected Anode Life (Years)	2.3	2.3	2.9
Overall Final C.D. (Milliamperes/Square Foot)	2.5	2.8	2.1

Figure 13—Exfoliation of barnacle layer on piling by calcareous deposit.

appreciable potential dip occurred amidships on the LST tenders, due to the remoteness of the anode strings which were necessarily suspended from the bow and stern sections only, and it was found necessary to carry these end sections at rather high levels in order to maintain protective potentials at all intermediate points.

It has been made standard practice to leave minimum platform potentials at —0.90 volts when the installation is finally adjusted, in order to provide a safety factor, or reserve, in the event of excessive storm damage or unforeseeable increases in underwater surfaces, such as would result from the addition of new well casings, steel dolphin pilings, platform extensions, and pipe lines.

A number of the platforms protected were connected to barge terminals on shore by means of well coated and wrapped 4-inch pipe lines several miles in length. Full protection of these lines was achieved by leaving them connected to the platforms and insulating them at the shore terminals.

The cost of applying cathodic protection to offshore drilling platforms of average size using magnesium anodes in the manner described amounts to no more than five or six cents per square foot per year for the initial two-year installation, including electrocating costs. Assuming substantially uninterrupted performance during the life of the system, current requirements should decrease with time as the calcareous coating continues to build up, and as a result subsequent replacement installations may either be smaller or else adjusted to longer life. In either case, cost per year of protection will be less than that for the original installation, and a gradual decline in cost with succeeding replacements may be anticipated. Hence, average annual cost of protection over a 10-year period may amount to as little as four cents per square foot.

There are several aspects of calcareous coating formation and maintenance which are worthy of note. Under certain conditions, during high current density treatment, the calcareous deposit forms under the rust or barnacle layer, thereby loosening the bond to the piling and causing portions of this material to be removed by wave action or vibration. E foliation of marine growth on a piling at the wat line which was observed a few weeks after cathod protection was installed is shown in Figure 13. Th The light colored calcareous deposit which has di placed a portion of the barnacle crust on the pilin is clearly visible. It should be pointed out, howeve that cathodic protection maintenance currents wi not prevent the growth of marine organisms o coated steel surfaces.

Another valuable feature of these coatings is the ability to provide a substantial degree of protectio to the underlying steel surfaces for a period of many months after the maintenance current is discontinued. Coating dissolution is a slow process and while it remains it maintains a relatively high pH next to the metal surface, helps to exclude oxygen and increases the internal resistance of naturally occurring corrosion cells on the coated structure. This property of the calcareous coating may become particularly valuable should severe damage to an anode installation occur during a hurricane or similar disturbance and repairs be inadvertently delayed for several months. Not only will be pilings remain substantially protected from corrosion, but protective potentials will be readily reestablished by providing again the original protective current density of 2.5-3.0 MA/sq. ft. Reapplication of the coating at high current densities should never be necessary if a satisfactory resurvey program is adopted.

There are certain precautions which should be observed in connection with these cathodic protection installations. Conductor pipes and casing strings should be adequately bonded together at the well head and then tied into the platform if such electrical connection is not already provided by production equipment and well head bracing. Production barges should either be electrically insulated from the platforms or bonded to it through an explosion-proof switch before loading. The former is probably preferable, because these barges ordinarily ride 100 feet or more from the platform; insertion of insulated flanges in the fill lines and insulating sections in the steel hausers provides the necessary protection from fire hazard and eliminates the excessive load on the protective system which would result from bonding of the unprotected barge to the platform.

Recent Trends

The acceptance of cathodic protection as a valuable adjunct to offshore drilling and producing operations is best illustrated by the fact that one large operating company incorporates anode supports in the design of jackets for all new platforms, and the anode strings are actually installed on such jackets on shore. Furthermore, while the best of protective coatings are applied to the upper portions of new jackets, including the anode supports, all continuously submerged metal is left bare, full reliance being placed on cathodic protection to eliminate corrosion on these surfaces. These steps are the logical outcome of long range planning with an eye to economy and are certainly to be commended where platforms are going into proven fields and there is little doubt

to their permanence. Figure 14 presents a rather unusual view of anodes installed on a jacket on shore a few days before it was moved to location; the line of demarcation between painted and bare jacket surfaces is also visible on the vertical jacket members.

Sufficient data have now been accumulated from completed installations to indicate that the actual life of the anode system after final adjustment will fall much closer to the nominal two-year design life if current requirements of those surfaces below the mud line are assumed to be only 60 percent of those in the water zone, i.e., if the area lying below the mud line is discounted 40 percent in computing total current requirements as outlined earlier in this paper. This approach appears desirable in order to keep initial costs down, although the net effect on cost of protection over extended periods may hardly be noticeable.

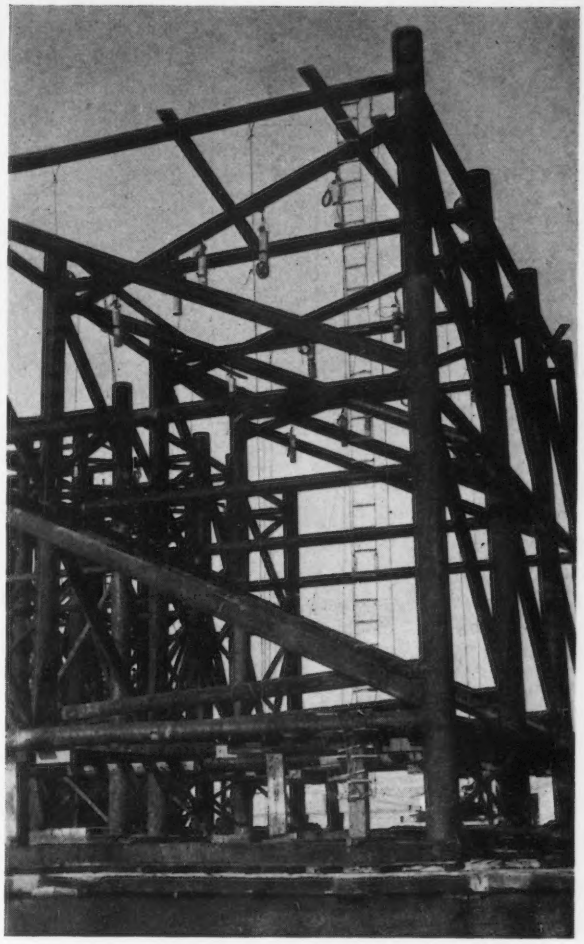


Figure 14—Anodes installed on platform jacket at shore construction base.

Corrosion Test Specimens

The need for data on corrosion rates of protected and unprotected steel pilings in the tidal zone under conditions actually encountered in offshore operations, plus the desirability of substantiating the effectiveness of cathodic protection on continuously submerged surfaces under such conditions, led to the installation of corrosion test racks on a cathodically protected producing platform below Morgan City, Louisiana. Six vertical channel racks, each supporting seventeen 6-inch x 6-inch No. 10 gauge mild steel plates on one foot spacings, were mounted side by side approximately 18 inches apart. The test plates were sandblasted prior to weighing and were bolted directly to the supporting channels. The racks were installed at such a level that the five top plates on each rack were located in the splash and spray zone, with the next three in the tidal zone and the nine bottom plates continuously submerged. All six racks were insulated from the supporting members, and alternate racks were then electrically connected to the platform through 0.01 ohm shunts. Figure 15 shows the test racks in place on the platform.

Unfortunately, an unavoidable lapse of several days occurred between the time the test racks were completed and the cathodic protection system was installed on this platform (November 13, 1949). Hence, although the three protected racks received the same polarization treatment and subsequent protective current as the platform pilings, they undoubtedly corroded at a very rapid rate during the few days they remained without protection. This is reflected in the rather high corrosion rate of 3 mils per year below low tide for one set of protected plates which were removed after four months exposure, as shown in Figure 16 (Curve B). The corrosion rate for a set of unprotected plates removed at the same time (Curve C) are also unusually high, presumably because the sandblasted plates were anodic to the channel supports.

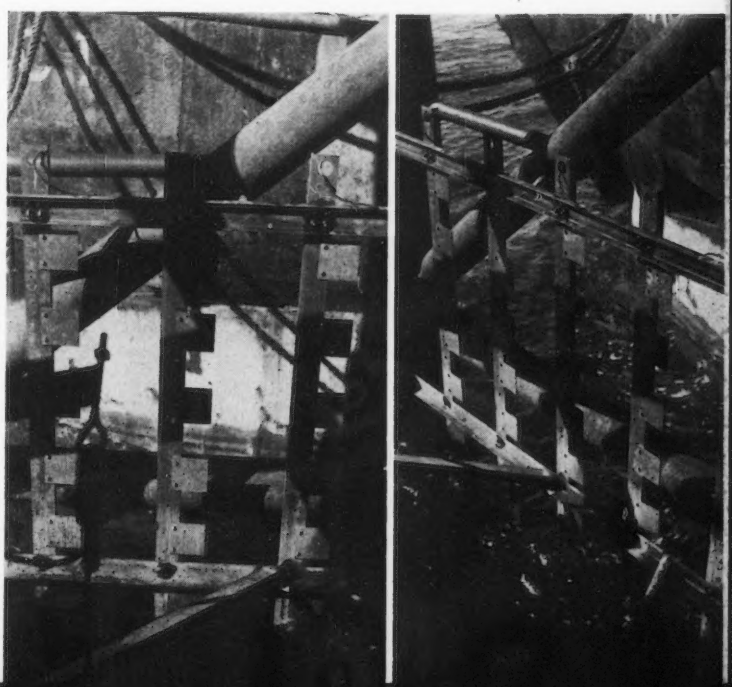


Figure 15—Corrosion racks in place on offshore platform.

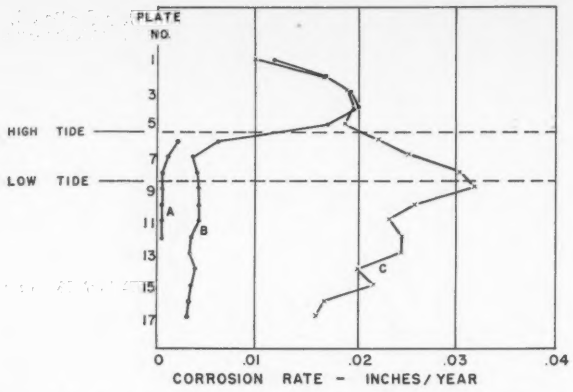


Figure 16—Corrosion rates of coupled mild steel plates exposed four months on offshore drilling platform. A—Protected. Coated at 300-400 MA/sq. ft. B—Protected. Coated at 100-150 MA/sq. ft. C—Unprotected.

The agreement between the corrosion rates of the two sets of plates in the splash and spray zone is very satisfactory.

Current checks during the first part of the polarization period indicated that the protected rack as a whole was receiving 100-150 MA/sq. ft. At the time the rack was removed a maintenance current density of 2.8 MA/sq. ft. was observed with potentials in excess of one volt negative to the calomel electrode.

In order to obtain data more representative of the true performance of cathodic protection, a smaller angle rack supporting only seven test plates was installed on this platform during the final survey of the completed protective system (December 9, 1949). These plates were polarized by means of a short length of Galvo-line, the rack being temporarily insulated from the platform for this purpose. A relatively high current density of 300-400 MA/sq. ft. was used overnight, following which this rack was electrically connected to the platform to maintain protection.

The corrosion rates for this set of test plates, adjusted to four months exposure for purposes of comparison, are shown in Curve A of Figure 16. Corrosion was substantially eliminated on the continuously submerged plates, while the corrosion rates in the tidal zone were much lower than expected, reaching a maximum of two mils per year, approximately, in the upper part of the tidal zone. These short-term data lend support to the viewpoint that the more dense coatings formed at higher current densities make cathodic protection much more effective in the tidal zone than generally is supposed.[5] The data presented should not be construed to imply that better results are obtained with coatings formed at 300-400 MA/sq. ft. than those formed at 100-150 MA/sq. ft., since a direct comparison was not obtained.

It is planned to remove a second pair of channel racks after one year of operation, and it is anticipated that the data obtained for the protected plates will be more representative than those given here in Curve B due to a reduction in the effect of the unavoidable initial weight loss on the results over an extended test period.

Summary

The manner in which cathodic protection has been applied successfully to the submerged steel surfaces of offshore drilling platforms, using sacrificial magnesium anodes as source of protective current, is discussed. By electrocoating the surfaces to be protected with high current densities of short duration overall current requirements for maintenance of protective potentials are reduced to 2.1-2.5 MA/sq. ft.

Design calculations and methods of installing the magnesium used for polarization and maintenance of protective potentials are outlined, and installation data for several different sizes and types of platforms are presented.

Cost of cathodic protection on offshore platforms of average size amounts to no more than six cents per square foot per year for the initial two-year installation, including electrocoating costs. A decrease in average annual cost over an extended period to as little as four cents per square foot may be anticipated.

Acknowledgment

The authors wish to thank Mr. Henry Allen and Mr. M. E. Parker, Jr., for their kind assistance in obtaining much of the experimental data presented in this paper.

References

1. H. A. Humble, *Corrosion*, **5**, 292 (1949).
2. H. A. Humble, *Corrosion*, **4**, 358 (1948).
3. G. C. Cox, U. S. Patents Nos. 2,200,469 (1940) and 2,417,064 (1947). British Patent No. 540,487 (1941).
4. Sir Humphry Davy, *Phil. Trans.*, **114**, 242 (1824).
5. G. C. Cox, private communication (1949).

A Rust-Preventing Pickling Inhibitor*

By KARL F. HAGER and MORRIS ROSENTHAL

Introduction

ACID PICKLING is a widely used industrial process for rust and oxide scale removal from iron and steel preparatory to steps such as electroplating, galvanizing, tinning, etc. Sulfuric acid, because of its low cost and reduced fuming hazard, is the most widely used pickling medium, but organic-type inhibitors are commonly added in order to reduce the acid attack on the basis metal without appreciably reducing the rate of acid attack on the oxides.

After this pickling, the surface of the ferrous metal is highly active and, unless aftertreatment follows soon after the pickling process, the metal rerusts rapidly. Results of experimentation in this laboratory indicate that a new class of pickling inhibitors has been developed which give excellent metal surface protection against acid attack without appreciably altering the rate of acid attack against the oxide and which also show excellent adhesion to the metal surface so that aftertreatment may be delayed several days after pickling without rerusting of the metal. This is of value to installations where there is no production line for pickling, rinsing, and after-treating and where derusting of metal is not a daily continuous practice.

Review of Inhibitors

Acid pickling inhibitors may be grouped into two classes: inorganic and organic componds. Inorganic inhibitors are salts of metals which have a comparatively high hydrogen overvoltage. Because the metals are more noble than iron, they are plated on the iron, forming a negatively charged, fairly continuous film over the metal surface. In the electrolytic cell formed by this iron-to-nobler-metal couple, the high hydrogen overvoltage of the deposited metal prevents the discharge of the hydrogen ions. This hydrogen polarization of the cathodic area also stops the reaction at the anodic area, thus preventing dissolution of the iron.

In general, organic inhibitors will be found to contain nitrogen, oxygen, sulfur, or other elements in the fifth and sixth periodic groups. The property is possessed by amines and their derivatives, heterocyclic nitrogen compounds and their derivatives, substitution products of urea and thiourea, mercaptans, organic sulfides, aldehydes, ketones and some organic acids. The inhibitor may be truly soluble in the pickling acid or may be colloidally dispersed. It seems evident that an inhibitor must consist of a hydrocarbon part attached to a polar or ionizable group.

★ Submitted for publication March 6, 1950.

DR. KARL F. HAGER, employed for the past five years in chemical research and development in the field of rocketry by the Department of the Army, Office of the Chief of Ordnance, Research & Development Div., Suboffice Rocket, received his PhD from the University of Wuerzburg, Germany in 1928. He is a member of TP-9—Corrosion Inhibitors Committee of NACE and also of ACS and AAAS.

MORRIS ROSENTHAL is Chemical Engineer, Aeronautics and Ordnance Division, General Electric Co., Fort Bliss, Texas, where he has been since 1948. He received his BChE from Polytechnic Institute of Brooklyn in 1945. His work in corrosion includes development of corrosion inhibiting additives for fuels and development of pickling inhibitors. He is a member of TP-9—Corrosion Inhibitors Committee of NACE.

Abstract

Results of experiments indicate a new class of pickling inhibitors has been developed which gives excellent metal surface protection against sulfuric acid attack without altering the rate of acid attack against the oxide appreciably and which shows also excellent adhesion to the metal surface so that "aftertreatment" may be delayed several days without rerusting of the metal.

The article contains a brief review of the properties of inorganic inhibitors, metallic salts having a relatively high overvoltage; and organic inhibitors, hydrocarbon - nitrogen - oxygen - sulfur compounds which adsorb on the cathode area and thus protect metal.

Emulphor STH, a wetting agent, is an effective inhibitor although inhibitors in this class generally have not been effective in giving more than brief protection against reoxidation of the pickled surface. Two types of steel were used to indicate effect of composition on inhibitors: SAE 1010 and Type 8617, HTS 3121, Spec. AN-QQS-676. Curves show increased inhibitor concentration improves percent retardation but not proportionately. Minimum effective inhibitor concentration varies with steel composition. A method of calculating percent of retardation is given.

Authors indicate irregularities in rate of attack are shown better by hydrogen evolution method, although slight errors are experienced at start. Because industrial pickling often is done at elevated temperatures weight loss experiments were carried out at 62-65 degrees C with slow stirring. To duplicate industrial conditions experiments also were conducted with rusted specimens. Three tests were made to determine the effectiveness of STH inhibition against rerusting. The STH film can be removed readily with dilute alkaline solution.

Conclusions are that Emulphor STH is characteristic of a new class of organic inhibitors which combine excellent inhibiting properties with a sustained rust-preventng effect on highly-active freshly pickled surfaces.

The "Corrosion Handbook"[1] lists 112 organic substances classified as inhibitors.

Many investigators have written about the desirable features of organic compounds which make them theoretically suitable for inhibitors.[2,3] One group holds that organic inhibitors bearing a positive charge migrate to the vicinity of the negatively charged cathode areas and are discharged and adsorbed there as a consequence of their unsatisfied valence bonds or they may form a layer of absorbed positive particles over the cathode area. In either case the discharge of hydrogen ions is inhibited by the presence of the positively charged film over the cathode area, or by the blanketing of the cathode area by the organic film and the consequent increase of interfacial resistance between the electrolyte and the metal surface. Interfacial resistance is the total effect of the organic layer at the cathodic area including the change in electrical resistance, apparent overvoltage, electrostatic repulsion, etc.

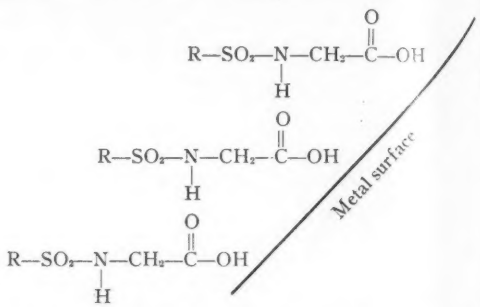
The cross-sectional area of the ions of the ionizable group of the organic inhibitor projected down on the metal and the closeness of the packing of ions in the covering layer will determine how effectively the metal has been blanketed and whether or not hydrogen ions can penetrate this layer to attack the metal surface. Systematic studies on the relation between structure and effectiveness of organic inhibitors discuss this idea in detail.[4]

Emulphor STH—Some wettting agents in low concentrations have been listed as effective inhibitors by various reviewers and companies. Of prime importance to this investigation is the fact that so far as the investigators have been able to ascertain, none of these commonly used wetting agents protects the freshly pickled ferrous metal surface against re-oxidation for any important length of time after removal from the acid bath.

Emulphor STH, a new wetting agent, has shown very promising properties as a cutting oil, textile lubricant and fuel additive. Its interesting structure and high metal affinity made it of interest for investigation as a pickling and after-pickling rerusting inhibitor. Representative of a new class of inhibitors, it is the sodium salt of a hydrocarbon-sulfamido-acetic acid,

$$CH_3(CH_2)_{11-17}\text{-}SO_2NH\text{-}CH_2COONa$$

An oily rest, useful in providing a film relatively impervious to hydrogen, is the major part of the molecule, yet it emulsifies and is easily dispersed throughout the pickling acid. The carboxyl group at the end of the carbon chain adheres to the metal surface and is a hydrophilic group. The bridge between the hydrophobic and hydrophilic groups has a peculiar quality, showing a hydrogen atom (bonded to the nitrogen) that is movable due to the influence of the activating sulfur dioxide group. This hydrogen is attracted by the negative carboxy group of the polar group of the adjoining molecule more than it is to the negative metal surface, so that a lattice-work protection of the metal is secured as follows[5]:



In this manner the molecules cover a great cross-sectional area of the metal surface, thereby preventing acid attack on the metal, preventing hydrogen gas generation and providing an extremely adherent, uniform film.

Experimental Results

Two methods of evaluating the performance of acid pickling inhibitors chosen from several other known methods were used as follows:

Method 1. Using 1-N sulfuric acid as the pickling solution, ground-surfaced steel pieces were subjected to a weight loss determination series. The surfaces of the steel pieces under test were ground to give areas of 27-29 cm², then degreased in a boiling alkali cleaner, rinsed with water, then with a 70% methanol

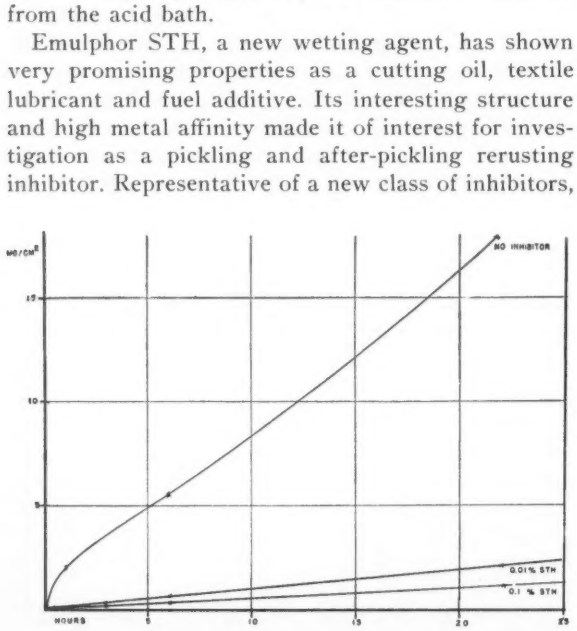


Figure 1—Steel NR. 1, weight loss mg/cm².

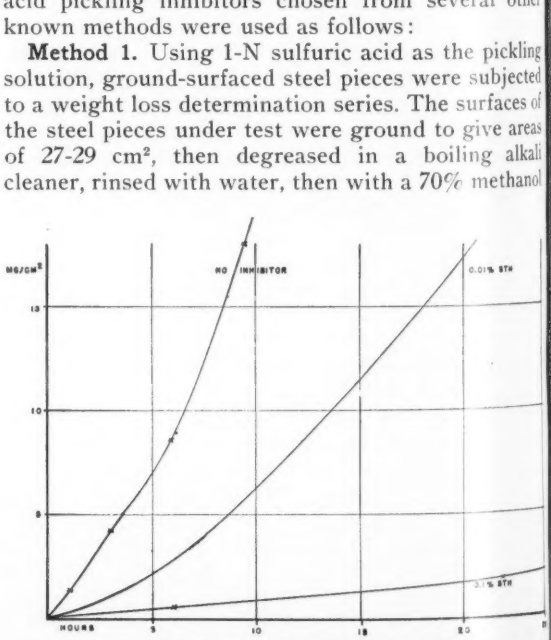


Figure 2—Steel NR. 2, weight loss mg/cm².

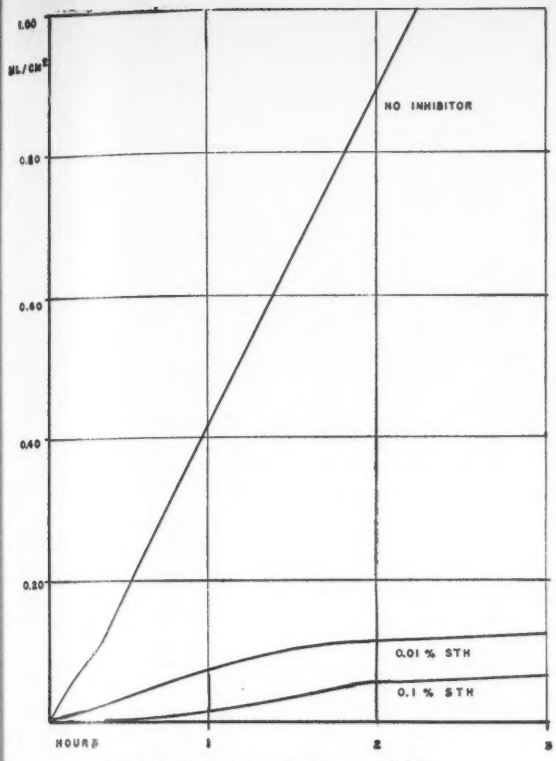


Figure 3—Steel NR. 1, hydrogen evolution.

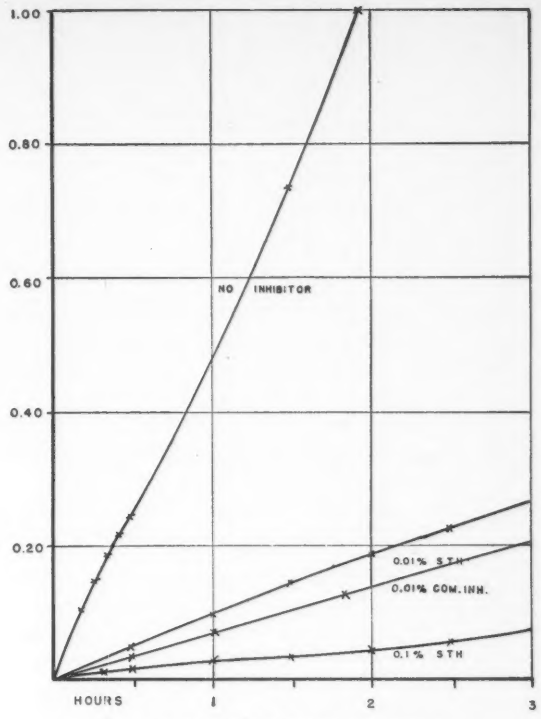


Figure 4—Steel NR. 2, hydrogen evolution.

solution (pH value of 7-8), and then immediately dried, weighed, and used. The pieces were suspended in 400 ml. of the acid in a covered beaker. In the case of the tests where Emulphor STH was added to the acid it was found to be immaterial whether a succession of specimens were removed after certain intervals in order to secure the data or whether the same specimen was removed, rinsed in water, dried, weighed, and returned to the solution. The strong adhesion of Emulphor STH to metal was further evidenced by these results. In the case of the control pieces and the other inhibitors tested, a succession of specimens removed after certain intervals was used as the method for obtaining the needed data.

Method 2. Using 1-N sulfuric acid, the steel pieces were subjected to hydrogen gas evolution determinations. Ground-surfaced test specimens prepared as before, were totally immersed in a special gas burette totally filled with the acid. Below the test piece a small overflow orifice led to an overflow tube, so that the entire system was at atmospheric pressure and the acid displaced by the hydrogen overflowed into a graduated container. This method was employed because it did not involve removing test specimens whenever readings were desired. The method also made it possible to obtain data at very frequent intervals not feasible when using the weight loss method because of the time and labor involved.

In order to indicate the effect of the composition of the steel alloys on inhibitors, two steels were used as test specimens.

Steel NR. 1 was an SAE 1010 steel, composition:

C 0.05—0.16	P less than 0.045
Mn 0.3 —0.6	S less than 0.055

Steel NR. 2 was type 8617, HT S3121, Spec. AN-QQS-676, composition:

C	0.165	Si	0.21
Mn	0.85	Ni	0.62
P	0.018	Cr	0.50
S	0.034	Mo	0.16

Steel NR 2 was heat treated, steel NR. 1 was not.

Figures 1 and 2 show that increased inhibitor concentration improves the percent retardation, but not proportionately. Likewise, the minimum amount of inhibitor concentration required varies with the steel composition and heat-treatment. As a result of the many alloying elements in NR. 2 steel, the rate of acid attack is increased. This is no doubt due in part to the many electrochemical cells set up by the various dissimilar crystals. As a consequence, it is necessary to have a higher interfacial resistance set up by the inhibitor. This is achieved by thickening the film by increased concentration.

Since the weight loss determinations do not permit spot checking of the results as frequently as desired (especially at the start), the hydrogen evolution tests were run with the results shown in Figures 3 and 4. The temperature was 23° C and the barometric pressure was 740 mm.

Figure 5 shows the close relationship of the results between the weight loss determination method and the hydrogen evolution method for steel NR. 1. The percent retardation was determined for periods and is not the average of the entire prior run, so that the change in rate of attack and retardation for certain periods of time during the pickling are determined. The percent retardation is calculated as follows:

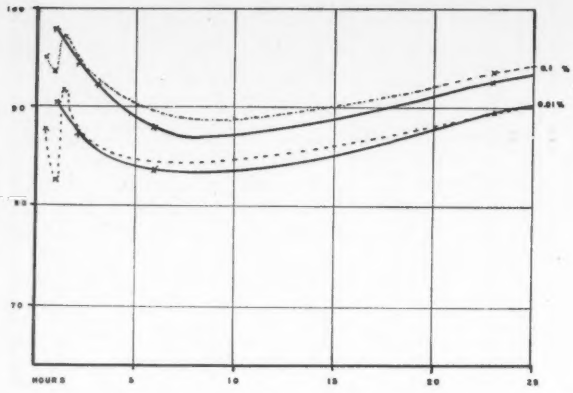


Figure 5—Steel NR. 1, percent retardation.

Weight loss———; hydrogen evolution - - - - - - -.

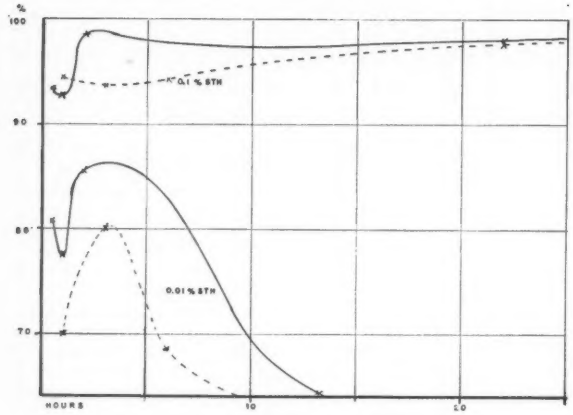


Figure 6—Steel NR. 2, percent retardation.

Weight loss———; hydrogen evolution - - - - - - -.

$$\% \text{ Retardation} = \frac{\left(\text{Rate of attack on control piece} - \text{Rate of attack on test piece}\right) \times 100}{\text{Rate of attack on control (uninhibited) piece}}$$

The irregularities in the rate of attack are better shown by the hydrogen evolution method and are easier to determine. However, at the start, the results are subjected to slight error because the acid must first become saturated with hydrogen before true readings are obtained, and also because slight surface irregularities affect the results more noticeably.

In Figure 6, it is shown that reproducibility of results is extremely difficult to obtain in cases where there is insufficient inhibitor for pickling complex alloy steels, because many more electrochemical reactions are permitted to occur between the crystals of the different alloying elements. The film covering the cathodic areas is not uniform over the metal surface.

In order to compare the results obtained by using these test methods with those obtained by other investigators using their own or similar methods, the hydrogen evolution test method was used on specimens immersed in 1-N sulfuric acid containing either 0.070 percent crotonaldehyde or 0.01 percent thiourea as inhibitor additives. Results are shown in Figure

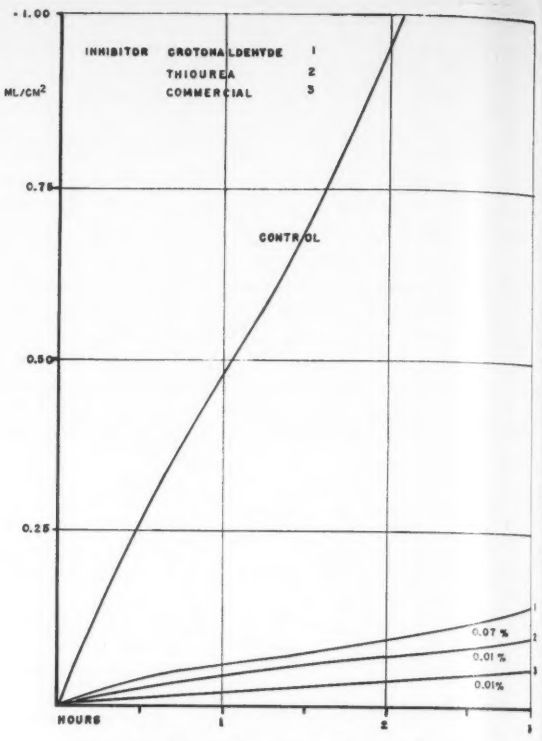


Figure 7—Hydrogen evolution ml/cm².

7. These tests showed that the methods employed in these experiments produced results comparable to those obtained by others employing their own approved methods.

The percentage retardations for crotonaldehyde in the case of steel NR. 1 ranged from 89 percent after 5 minutes to 87 percent after 5800 minutes, which is sufficiently close to the 90 percent retardation reported by C. A. Mann and associates[1] who employed a mild steel similar to the SAE 1010 employed in these experiments. The effect of the thiourea inhibitor during the 48-hour tests was found to possess a 93 percent retardation, which also is close to the 90 percent reported by others.[1]

When steel NR. 2 was used as the test piece on a weight determination series with the 0.070 percent crotonaldehyde inhibitor, the retardation ranged from 51 percent after 18 hours to 46 percent after 48 hours. In Figure 4, one of the curves shows the effect of addition of 0.01 percent of a commercial inhibitor to 1-N sulfuric acid in the pickling of steel NR. 2. Upon comparison of this curve with the curve of this same inhibitor in Figure 7, the effect of steel composition on the inhibitor efficiency is clearly defined. A rule may be stated that: The necessary concentration of inhibitor to produce the effect desired must be determined first by experimentation with the different composition steels.

Because pickling frequently is carried out in industry at elevated temperatures, principally to reduce the pickling time, and because raising the temperature tends to make inhibitors less effective[6], some weight loss determinations were made at a tempera-

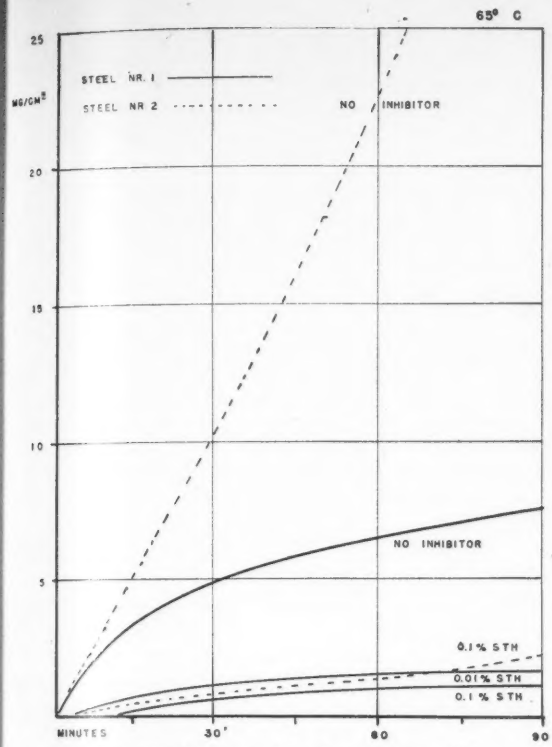


Figure 8—Weight loss at elevated temperature, 65°.

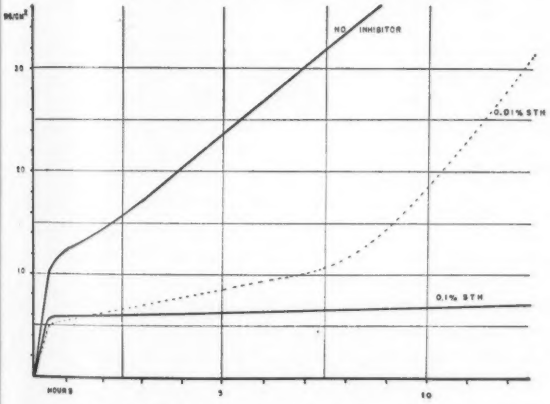


Figure 9—Rusted steel, weight loss mg/cm.²

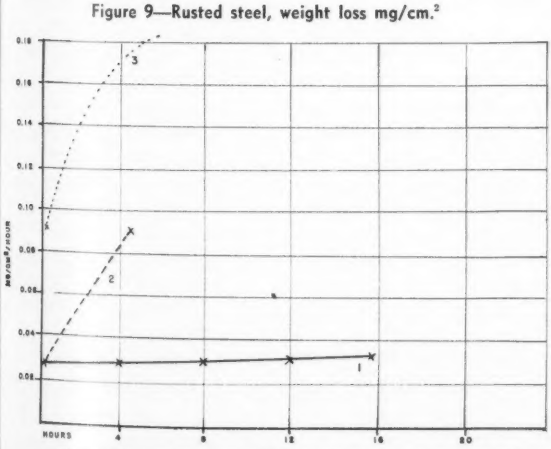


Figure 10—Stability of STH film against fresh acid attack. loss mg/cm² hour.

ture range of 62-65°C, with slow stirring. Table 1 and Figure 8 show results of these tests.

TABLE 1

Retardation at Elevated Temperature

Time, Minutes	STEEL NR. 1 0.1% STH	STEEL NR. 1 0.01% STH	Steel NR. 2 0.1% STH
15	91.1%	80.2%	92.3%
30	90.0%	77.4%	92.8%
60	85.0%	75.4%	94.5%
90	84.6%	78.0%	.....
120	.....	.....	97.2%

As can be seen in Figure 8, steel NR. 2 is attacked at a greatly accelerated rate at elevated temperatures, hence, even with more weight loss in mg/cm² for steel NR. 2 at 0.1 percent STH concentration than for steel NR. 1, under the same conditions, the steel NR. 2 exhibits a higher percent retardation. Because pickling at elevated temperatures such as this normally is for periods of ½ hour or less, the 0.1 percent STH inhibitor retardation is sufficient for the high 90 percent retardation set as the standard.

A commercial inhibitor tested under the same conditions as the STH, employing steel NR. 1 as the test specimen material, showed a retardation of 80 percent after 30 minutes and 74 percent after 90 minutes when present in 0.01 percent concentration. In 0.1 percent concenrtation this commercial inhibitor showed a retardation of 90 percent after 30 minutes of pickling time.

Up to this point the tests were designed to observe acid attack and inhibition on the pure metal. Because previous investigators reported that oxides act as accelerators of acid attack against the basis metal[7,8], the test needed to justify the use of STH for plant use was to conduct a weight loss determination on metal pieces already rusted.

Pieces of steel NR. 2 were rusted under controlled humidity conditions. These pieces were carefully split in two, one half was analyzed for total rust content, and the other piece was used in the tests. By boiling a weighed, rusted piece in an NaOH solution with zinc dust present, the final weight yielded the weight of rust present.

The three pieces used in the test, the results of which are shown in Figure 9, all had about 5.2 mg rust per sq. cm. The rate of oxide attack was not affected to an appreciable degree by the presence of the inhibitor, and the retardation was over 91 percent when the 0.1 percent STH was used. Thus, STH protects the metal without affecting the attack on the oxide.

The tests which showed that STH possessed the power of inhibition against rerusting are as follows:

Test 1. The most severe test was to determine if the STH film deposited on the metal during pickling could protect the metal against fresh acid attack. Steel NR. 1 was pickled for 1½ hours in 1-N sulfuric acid, inhibited with STH, at 23°C, rinsed, dried, and weighed. Following this, the metal was put in fresh, uninhibited 1-N sulfuric acid for 16 hours and the weight loss determined. Then it was put in another acid bath for four hours, weighed, and finally it was put in another fresh acid bath for several hours. Fig-

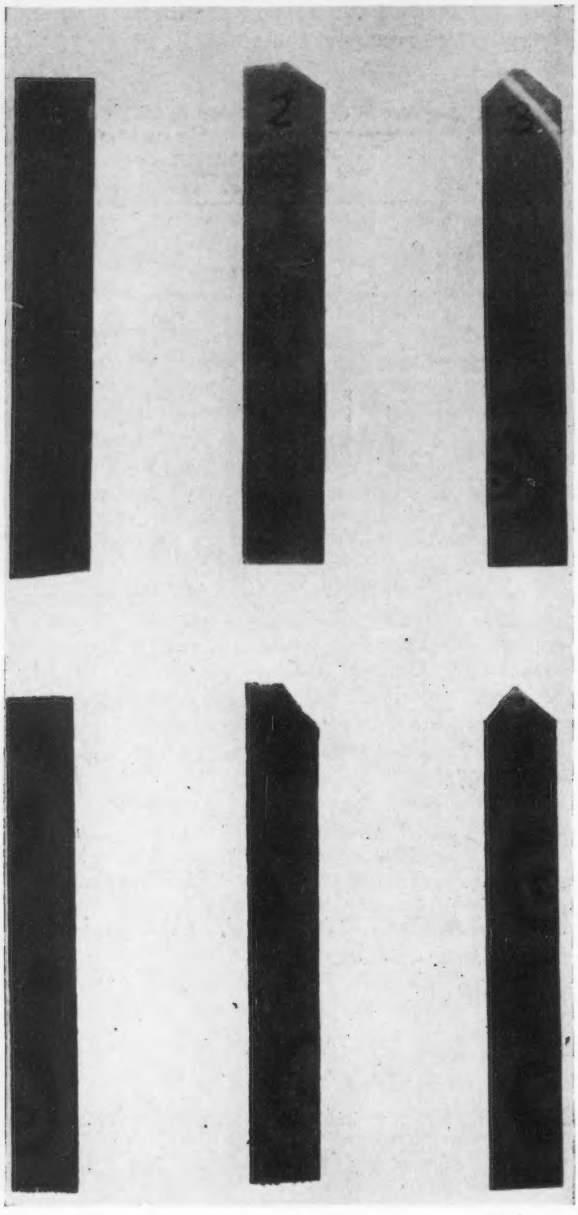


Figure 11

ure 10 shows that the film had excellent stability on the first test, weakened on the second test (but the retardation was still over 90 percent), and failed rapidly on the third test.

Test 2. More representative in severity to what would happen if the test pieces were pickled, rinsed and allowed to dry in the air is the following test. Three pieces each of steel NR. 1 and NR. 2 were pickled in uninhibited, 0.01 percent STH inhibited, and 0.1 STH inhibited 1-N sulfuric acid for four hours respectively, rinsed with water and air dried. The specimens then were alternately rinsed and dried for several cycles. The uninhibited acid specimens started rusting very rapidly, whereas the 0.1 per cent STH inhibited specimens remained completely rust free after many such cycles. Steel NR. 1 in 0.01 percent STH treated acid also had no rust, but steel NR. 2 in 0.01 percent STH inhibited acid rusted at a slower rate than the uninhibited pieces. Figure 11 shows the results where pieces 1, 2, 3 are NR. 1 steel and pieces 4, 5, and 6 are NR. 2 steel. Pieces 1, 4 were uninhibited, pieces 2, 5 were 0.01 percent STH inhibited, and pieces 3, 6 were 0.1 percent STH inhibited.

Test 3. Five pieces of steel NR. 1 were pickled for one hour in 1-N sulfuric acid in five different beakers containing different inhibitors. The pieces were removed after being treated in their respective acid baths, rinsed with water to remove the acid, and air-dried. Figure 12 pictures the results of this test. Piece 0 was inhibited with 0.07 percent crotonaldehyde, piece 1 was inhibited with 0.01 percent thiourea, pieces 3 and 4 were treated in acid inhibited with 0.01 percent and 0.1 percent commercial inhibitor respectively and the unnumbered piece was in 0.01 percent STH inhibited acid. The latter piece had no trace of rerusting anywhere on its surface, whereas the other pieces were all badly rerusted.

Test 4. Steel NR. 1 underwent a hydrogen evolution test for 100 hours in 1-N sulfuric acid. The results are shown in Figure 13.

The after-pickling protection of this class of compounds is due to the high affinity of these materials toward metals. Emulphor STH, because of its anti-corrosion properties and its adherence to metals has been used widely as a cutting oil in metal processing operations.[9] In deep-drawing of shell casings STH was found to produce a perfectly smooth finish without striations, giving evidence of the excellent adherence of the Emulphor STH film to the steel throughout the entire operation. In cold drawing operations, plant operators preferred the use of STH to the tallow teatment normally used.

Despite the strong adhesion of the STH film to the metal, it can be readily removed by washing with a dilute alkaline solution whenever it is desired. It was found that pieces of steel pickled for two hours in 1-N sulfuric acid inhibited with 0.1 percent STH lose their film of STH, which protects them against rerusting, after a rinse with 5 percent NaOH solution. The pieces were pickled as one piece which was then cut in two parts. One part was washed in water, the other in the alkaline solution. Following this, the pieces were alternately rinsed and dried for several cycles. Rust built up on the piece washed with alkali, but the other piece remained unchanged.

Because of the fact that STH can be removed by means of a dilute water solution of an alkali, disposing of the protective film, it does not entail the use of organic solvents. The film is not of a detrimental nature insofar as oiliness is concerned.

In these experiments, the Emulphor STH used was a technical preparation of the following composition:

42—50% Mepasin-sulfamido-carboxylic acid (active ingredient)
45—50% Unreacted Mepasin Oil
5— 8% Water.

Thus, insofar as the active ingredient concentration is concerned throughout this discussion, the values

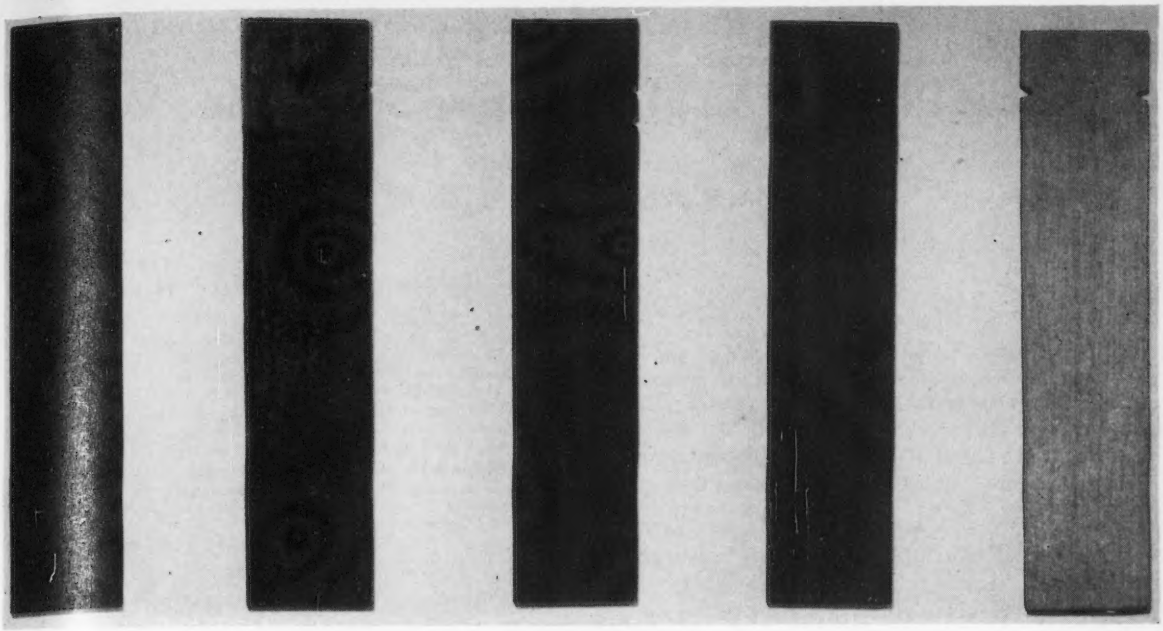


Figure 12

for the STH concentration given in percentages should be reduced by approximately half.

Conclusion

In Emulphor STH, a new class of organic inhibitors against acid attack on steels has been found, which combines normal inhibiting properties with a successful rust preventing effect on the highly active, freshly pickled surface. Insofar as its pickling inhibitor properties are concerned, it has been found to be comparable to commercial inhibitors, but its chief significance lies in its excellent rust preventing effect lasting long after the pickling process has been finished. Its high metal affinity, however, causes a water repellant film on the metal surface making its removal necessary before such processes as electroplating, etc., are performed. This disadvantage is partially overcome by its ease of removal from the metal by means of a dilute alkaline water solution.

In strong acid solutions, STH has the disadvantage of only fair stability with respect to commercial inhibitors.

Because of its high affinity to metals and its corrosion inhibiting properties, this class of compounds opens a field where further research and development work are desirable and necessary.

Acknowledgement

Experimental work was done in Chemistry Laboratory of Ordnance Research and Development Division Suboffice (Rocket), Fort Bliss, Texas.

Publication authorized by the Office of the Chief of Ordnance, Department of the Army, but responsibility for work is personal.

The authors thank Col. H. N. Toftoy and Maj. James P. Hamill for their cooperation and permission to publish this report.

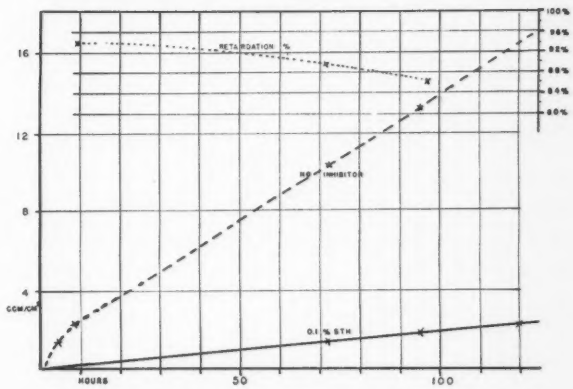


Figure 13—Long range effect of 0.1 percent STH. ccm/cm² hydrogen evolution.

References

1. Corrosion Handbook, H. H. Uhlig, editor.
2. C. A. Mann, *Trans. Electrochem. Soc.*, **69**, 115-119 (1936).
3. H. P. Munger, *Trans. Electrochem. Soc.*, **69**, 85-104 (1936).
4. C. A. Mann, B. E. Lauer, C. T. Hultin, *Ind. Eng. Chem.*, **28**, 159, 1048 (1936).
5. J. M. Michel, K. F. Hager, *Ind. Eng. Chem.*, **41**, 2616-2622 (1949).
6. Creighton and Kohler, *Electrochemistry*, **1**, 250-275 (1935).
7. K. Wickert, *Archiv fur Metallkunde*, **2**, 56-62 (1948).
8. W. Machu, *Korrosion und Metallschutz*, **10**, 277 (1934).
9. K. F. Hager, and M. Rosenthal, *Am. Machinist*, August 25, 1949.

Cathodic Protection of an Active Ship in Sea Water*

By K. N. BARNARD and G. L. CHRISTIE

Introduction

IN JUNE, 1949, a paper was presented at Kure Beach describing two trials of cathodic protection of active ships using magnesium alloy anodes. These ships were 40-foot steel tugs. The test has now been in progress for about 16 months and the underwater hulls have been kept free from corrosion in spite of large areas of exposed steel. A similar tug that was given the same hull treatment but was fitted with Grade II zinc protectors, shows considerable corrosion and its propeller was removed for reconditioning November 3, 1949. Severe paint stripping took place on the tug fitted with a magnesium anode having no control. There was little difference in paint stripping between the tug fitted with a controlled magnesium anode and the one fitted with zincs.

The success of these trials warranted a further test with a larger active ship fitted with a controlled magnesium anode protection system. The results of this test will form the basis of this paper.

Treatment in Drydock

In June, 1949, HMCS "New Liskeard" was drydocked for painting. This ship is an Algerine class minesweeper (length 225 ft., beam 35½ ft., underwater area 7500 sq. ft.; 960 tons displacement), on active duty with the Royal Canadian Navy, as an experimental and oceanographic ship. When drydocked the paint on the hull was in reasonably good condition and the fouling growth was very light. The hull was only wire brushed where it appeared necessary, and two coats of iron oxide pigmented anticorrosive and one coat of cuprous oxide antifouling paint were applied. The zincs normally fitted in way of outlets and at the stern were removed and not replaced.

The protection system used consisted of ten magnesium alloy anodes measuring 3" x 7" x 60" and weighing about 80 lbs. each. Five anodes were secured to the bilge keel on each side but insulated from the hull of the ship. A 5/16-inch solid copper core, threaded at the ends, was cast in each anode and served as the electrical connection to a rubber covered cable (area of copper 78,000 circular mils) roughly equivalent to a B. & S. No. 1 solid copper wire. After the electrical connections were made the joints were soldered.

The five anodes on each side were connected in parallel and a single lead from each group was passed through a packing gland in the side of the ship to a coffer dam and stand pipe. Each lead wire was then taken to a 0.5 ohm variable resistance and an ammeter before it was connected to the frame of the ship.

Figure 1 is a section of the ship at the bilge keel and shows the position of the anodes. Figures 2 and 3 show the anodes as fitted to the bilge keel, and the electrical wiring. The anode holders were made from ⅛-inch steel plate welded to the bilge keel. The anode fitted into a recess in the holder lined with ⅛-inch rubber sheet for insulation. The securing

★ A paper presented at the Sixth Annual Conference, National Association of Corrosion Engineers, St. Louis, Mo., April 4-7, 1950.

K. N. BARNARD—A graduate of the University of Saskatchewan (BSc and MSc (Physics) in 1937) he spent 1937-40 in geophysical prospecting in Northern and Eastern Canada. In 1941 he joined the Department of National Defense at Halifax, N. S. as research physicist. Some of his work during the war years led to the present corrosion research program at Naval Research Establishment, Halifax, a division of the Defense Research Board of Canada.

G. L. CHRISTIE—Born in Western Canada, he graduated from the University of Saskatchewan with BSCE degree in 1937, and from McGill University with PhD in 1948. He has been two years with the National Research Council and six with Aluminum Company of Canada. Since obtaining his doctorate he has been on the staff of the corrosion section of the Naval Research Establishment, Halifax, N. S.

Abstract

H.M.C.S. "New Liskeard," an Algerine Class minesweeper (length 225 ft., beam 35½ ft., underwater area 7500 sq. ft., 960 displacement tons) on active duty with the Royal Canadian Navy, has been fitted with a cathodic protection system using magnesium alloy anodes.

In June, 1949, ten magnesium alloy anodes, 3" x 7" x 60" weighing about 80 lbs. each, were secured to the bilge keels but insulated from the steel of the hull.

Hull potential readings with respect to a silver-silver chloride electrode in sea water show that the hull is protected while at rest. Underway the degree of polarization decreases slightly.

By securing the anodes on the bilge keel there appears to have been a loss in effectiveness caused by uneven distribution of current with varying distance from the anode.

Results to date indicate cathodic protection of an active ship of this size is economically practical.

stud bolts passed through an upper steel plate, through insulating sleeves in the anode and threaded into a nut welded to the holder. Thus the steel parts holding the anode were connected to the ship but insulated from the anode. Protector plates were fitted at the ends of the anodes to give a slight streamlining effect and to protect the electrical connections from mechanical damage.

Experimental

On 23 June 1949 the ship was undocked and secured at a jetty berth with manila lines. For the next five days the anodes were not connected to the ship. During this time the potential of the hull as measured with a silver-silver chloride electrode, rose from 417 mv to 578 mv indicating some breakdown of the paint film. On June 28 the anodes were connected and the current adjusted to 10 amp. on each side and held at that value until July 11. The record of this polarization is shown in Figure 4. If a hull potential of 760 mv with the anodes disconnected momentarily is used as a criterion of protection, this ship was protected after ten days.

Figure 1—Cross section of the hull at the bilge keel showing the approximate position of the anodes.

On July 11 the ship was taken out on speed trials. Over a period of three hours the hull potential dropped from 760 mv to a low of 718. After 14 hours at the jetty berth the potential was once more up to 760 mv.

From July 13 to 15 an oceanographic cruise was made to the Nova Scotia shelf. By the second day the hull potential had dropped to 600 mv with a current of 34 amp. This current was not sufficient to protect the hull at this time.

From July 17 to 27 a cruise was made from Halifax to Boston and return. On this trip the potential was about 700 mv with a current of about 32.5 amp. A record of this cruise is given in Table 1 and shows, even at this early date, some improvement over that obtained the previous week.

From Aug. 1 to Oct. 27 the ship operated on experimental work out of Halifax, which involved

TABLE I

DATE	Time	Hull Potential	Current	Speed
17 July 49	1200	704	32.5	U.W.
17 July 49	1900	694	32.6	U.W.
19 July 49	0810	720	31.8	U.W.
21 July 49	0815	784	29.7	0
22 July 49	0815	816	29.2	0
23 July 49	0815	704	29.2	U.W.
24 July 49	0845	700	29.3	U.W.
25 July 49	0800	698	29 2	U.W.
26 July 49	0815	700	31.2	U.W.
27 July 49	0815	704	29.8	U.W.

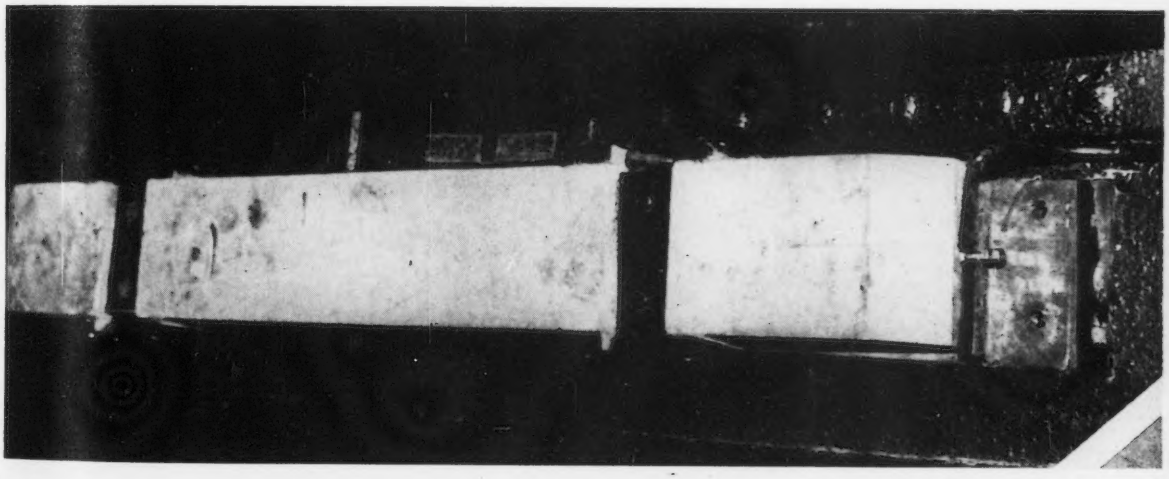


Figure 2

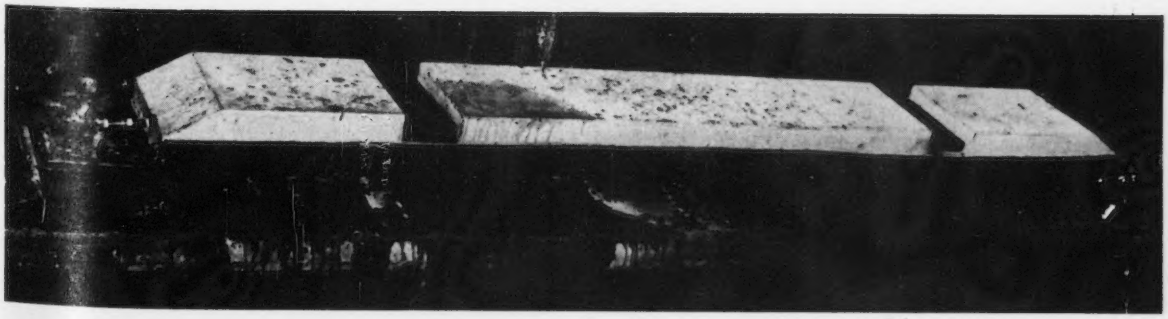


Figure 3

TABLE II

DATE	Time	Hull Potential	Current	Speed
12 Sept. 49	1600	838	32.3	12
13 Sept. 49	0930	844	29.8	0
14 Sept. 49	1100	840	32.8	12
14 Sept. 49	1130	844	33.2	15
14 Sept. 49	1200	848	33.1	15
14 Sept. 49	1230	844	33.2	15
14 Sept. 49	1300	854	33.5	15
14 Sept. 49	1330	850	33.3	15
14 Sept. 49	1400	844	33.2	15
14 Sept. 49	1430	842	33.2	15
14 Sept. 49	1500	840	32.8	15
14 Sept. 49	1600	844	33.5	15
14 Sept. 49	1700	842	33.2	15
14 Sept. 49	1800	830	34.2	15
14 Sept. 49	1900	840	34.1	0
14 Sept. 49	2000	....	32.3	13

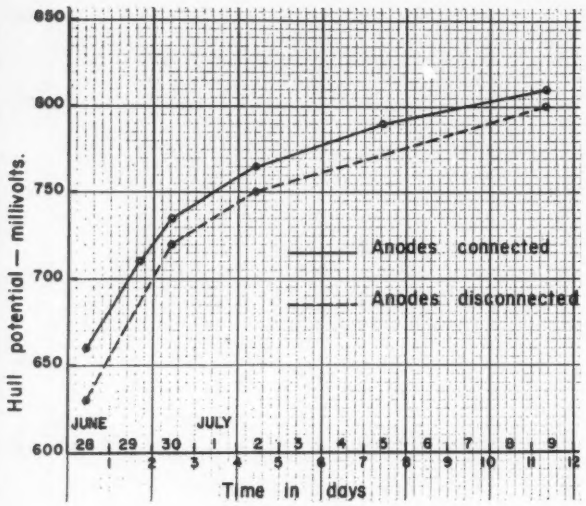


Figure 4—Polarization of the hull at a total current of 20 amperes.

steaming by day and returning to the jetty berth at night. The potential record over this period is very much better. Table II shows the record for 12 to 14 September, 1949. Hull potential measurements did not go below 830 mv even after 10 hours underway.

Aside from known accidents where New Liskeard was connected to other ships by metallic conductors, the potentials recorded both underway and at the jetty have varied from 800 to 872 mv over this three month period. These values show the ship was protected. The mean of the current output of a series of readings taken with the ship underway and the hull potential between 820 and 840 mv was 31.9 amperes. With the same range of hull potential and the ship stationary the current required was 29.4 amp.

With the exception of the first month of operation there has been little difficulty in keeping the hull polarized to a protected value. When the ship gets underway the depolarization is very slight and the increase in current output of the anodes is only about 12 percent. This is automatically supplied by the anodes when the ship gets underway.

The record of the first months of operation indicate that the age of the polarization film is a controlling factor in determining the severity of the depolarization when the ship is in motion.

On 25 October 1949 "New Liskeard" was taken out of active service and put into refit for alterations to her superstructure. While she is still afloat the record is that of a stationary ship complicated by construction work and steam connections.

When the record of the "New Liskeard" is compared with that of HMCS "Wallaceburg," an inactive ship of the same class, protected by magnesium anodes suspended at a distance, it can be seen that there is some loss of effectiveness when then anodes are secured to the hull. With the same water temperature about 12 amperes were required for the "Wallaceburg" compared with about 29.4 amperes for "New Liskeard" or a factor of about 2.5. Other work indicates that the reason for this loss of effectiveness of the anodes when secured to the hull is the low resistance of the sea path in the immediate vicinity of the anodes. This low resistance concentrates a large proportion of the total current over a small area of the hull. The size of a ship on which this system could be used and still obtain adequate protection has not been determined.

The average current density over the hull is 4.5 ma per sq. ft. at 34 amp. total current. If cast magnesium alloy anodes are available at $0.50 per pound this gives a cost of 5 cents per sq. ft. per year, or a cost of $400 per year for this ship exclusive of the cost of installation.

Conclusion

From the test work completed to date it can be concluded that for a ship with an underwater area up to 10,000 sq. ft., a magnesium protection system is practical and adequate. From an economic point of view the costs are higher than those encountered where the anodes can be suspended at a distance from the steel being protected but still in the range where a saving would be realized over the life of a ship. This saving would be shown in lower hull maintenance costs and, on small ships, in less expensive paint systems.

Acknowledgment

The work here reported was carried out in the laboratories of the Naval Research Establishment, Halifax, N.S. The authors express their appreciation to the Defence Research Board of Canada and to the Royal Canadian Navy for the support they have given to the investigation and for their permission to publish the results.

Topic of the Month

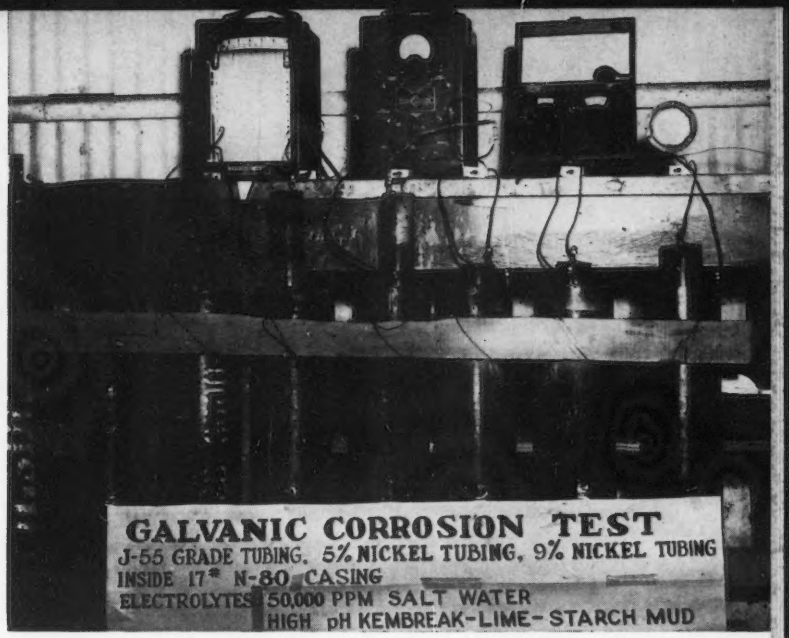

GALVANIC CORROSION TEST
J-55 GRADE TUBING, 5% NICKEL TUBING, 9% NICKEL TUBING
INSIDE 17* N-80 CASING
ELECTROLYTES 50,000 PPM SALT WATER
HIGH pH KEMBREAK-LIME-STARCH MUD

Figure 1—Equipment used in study of galvanic corrosion between 9%:5%. Ni steel tube and N-80 casing.

Results of Galvanic Corrosion Tests Involving 9% and 5% Nickel Steel Tubing Coupled to N-80 Casing

THE POSSIBILITY of injury to casing from the presence of the Nickel alloy steel tubes, now widely used in condensate wells, has prompted tests by laboratories of several oil companies. The Sun Oil Company, Gulf Coast Division, has made studies of galvanic corrosion occurring when 9% and 5% Nickel steel tubing is coupled with N-80 casing. A summary of a set of tests has been supplied by Mr. W. H. Stewart* of the Sun Oil Company, Beaumont, Texas.

Tests and Results

"Due to the possibility of galvanic action between 5% and 9% nickel alloy tubing and N-80 casing in a well that has the annular space filled with a drilling fluid or salt water, several cells have been built to simulate well conditions. (Figure 1)

"The cells consist of 30-inch lengths of 2-inch 5% nickel, 2-inch 9% nickel, and 2½-inch J-55 tubing set inside 17 lb. N-80 casing, with the bottom sealed and insulated with tar. The annular space in one test series was filled with Kembreak-lime-starch drilling mud, and another series was filled with 50,000 ppm salt solution. The top of the liquid in the annular space was covered with a 2-inch layer of oil to prevent oxygen intrusion and evaporation. The J-55 cell is being run as a control.

"The electrical current and voltage measuring equipment consists of a General Radio direct current amplifier, coupled to an Esterline Angus recording milliammeter, as well as a Leeds & Northrup potentiometer. Electrodes were brazed to both the casing and tubing. Continuous current readings and spot voltage readings were taken with the cells on a dead short.

"As a further check, two galvanic cells consisting of a copper SAE 1020 steel couple were prepared with 50,000 ppm salt water as the electrolyte. One cell is exposed to the air, and the other has oil placed on the top to exclude oxygen.

"This was done to demonstrate the effect on corrosion rate of galvanic couples in aerobic and anaerobic conditions.

Results

"The results indicate that the current flow rapidly drops from 9 milliamperes to 0 milliamperes in about 24 hours, which is to be expected. The cell apparently polarizes after the dissolved oxygen is used up. The test was run for 90 days, and at the end of that time there had been no further current increase, and visual inspection of the casing showed no signs of corrosion.

"The results from another laboratory corroborated our findings. The data obtained in their test showed that there is a "persistent (open circuit) voltage" even after the cell has been shorted for a period of several months, but that this voltage is decreasing with time."

*Corrosion Engineer, Sun Pipe Line Company.

NACE News

Hoxeng Is Elected Cleveland Chairman

New officers for Cleveland Section, elected April 25, are as follows: Raymond B. Hoxeng, Case Institute of Technology, chairman; L. W. Davis, Aluminum Co. of America, vice-chairman; Charles N. Detrick, Williams and Company, secretary-treasurer. Elected to the advisory council were U. T. Green, Diamond Alkali Company; C. J. Wertz, The Cleveland Union Terminals Co.; W. E. Baker, Standard Oil Co.; Edward Dyble, Cleveland Diesel Co.

TP-6 Adds Division on Masonry Construction

A new subdivision of Technical Practices Committee No. 6—Protective Coatings has been organized as TP-6K—Chemical-Resistant Masonry Construction. Robert R. Pierce, Product Supervisor of Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia, Pa., has been named chairman.

L. L. Whiteneck, Senior Harbor Engineer, Board of Harbor Commissioners, Long Beach, Calif., has been named West Coast coordinator of TP-6 by Kenneth Tator, chairman of the committee. Active response at the organization meeting of the subdivision at Los Angeles, April 26, was reported by Whiteneck. The committee will be active on protective coatings for atmospheric, marine and petroleum exposures and surface preparation for coatings. Metallic and organic coatings will be investigated by the committee.

Association President Vance M. Jenkins III

Vance N. Jenkins, president of the National Association of Corrosion Engineers is ill and is expected to be away from his work at Union Oil Company of California, Wilmington, Calif., for the next five or six weeks. This information from the research department of the company did not elaborate on the nature of Mr. Jenkins' indisposition.

Association work normally carried out by the president at this time is expected to be shifted to other officers of the NACE until Mr. Jenkins has recovered.

Sabine-Neches Section Elects New Officers

New Officers of Sabine-Neches Section are Joseph J. Picarazzi, Cities Service Refining Corp., Lake Charles, La., chairman; Richard P. Clarke, Atlantic Refining Co., Port Arthur, Texas, vice-chairman; Frank R. Jelinek, Neches-Butane Products Co., Port Neches, Texas, secretary-treasurer.

Corrosion News Deadline:
10th of Month *PRECEDING* Date of Issue

Billhartz Addresses North Texas Section

H. L. Bilhartz, Atlantic Refining Co., Dallas, Texas, spoke to North Texas Section May 29 at a dinner meeting held at Venus Restaurant, Dallas, Texas. A fellowship hour began at 6:30 p. m., followed by dinner, afer which Atlantic Refining Company's laboratories were inspected. Mr. Bilhartz' topic was "An Engineering Approach to the Study of Corrosion Problems Encountered in the Oil Producing Industry."

A summary of Mr. Billhartz's remarks follows:

Expenditures in the millions of dollars annually have brought organized company-wide and industry-wide approaches to the problem of corrosion in the oil producing industry. A typical plan of attack on a corrosion problem may be as follows: Organization, three basic units—1) Field engineers and operating personnel; 2) a mechanical engineering group and 3) a chemical engineering group. The first has practical acquaintance with actual operations, the second is concerned with the selection of equipment and the third in the technical solution and economics of corrosion problems.

A problem may be conceived and action initiated by any of the three basic divisions. For example, field personnel may observe costly conditions; a mechanical engineer in his routine cost study may locate a problem from production costs data, or the chemical engineer, examing routine analytical data from operating areas, may point out corrosive environments prior to equipment failure.

Once conceived, the problem is defined from an economic standpoint by the mechanical section, and this is followed by a preliminary survey by the chemical section designed to indicate the "success factor." Technical aspects are reviewed and probabilities of successful completion at reasonable cost evaluated. These data, when correlated with the mechanical section's study, will determine the extensiveness of the investigation.

If at this stage a project appears economical, an extensive investigation is undertaken by the chemical engineering group involving data compiled from field and laboratory tests. Simultaneously records and results of past investigations are assayed for evidence of positive patterns. During this time engineers from the laboratory spend considerable time in the field, where a most important source of information is developed from the personal observations of field personnel. Samples are collected to the extent considered necessary and then an attempt is made to evaluate data.

This is the most difficult step in the engineering approach to a corrosion problem because the significant facts must be extracted from a mass of often inconsequential facts. Preliminary conclusions drawn from this evaluation, usually the result of trends or negative data, lead to accumulation of more positive evidence through pilot studies or controlled field trials.

Finally, after each proposed solution has been considered and the best remedial measure ascertained, a report of the investigation is prepared. The final step is an organized approach to the evaluation of results of recommendations and at this point active responsibility reverts to the mechanical section, because economic gains must tell the story. Although results may appear technically satisfactory, a reduction in operating costs will determine the success of an investigation finally.

1950-51 Officers Named By St. Louis Section

Results of the election of section officers for 1950-51 were announced as follows at the May 15 meeting of Greater St. Louis Section which was attended by 30 members and 20 guests. Officers elected were:

Frank Whitney, Monsanto Chemical Co., St. Louis, chairman; George A. Fisher, Jr., The International Nickel Co., Inc., St. Louis, vice-chairman; Charles Swartout, Mallinckrodt Chemical Co., St. Louis, secretary; George Purdy, Tretolite Co., St. Louis, Mo., treasurer. Four directors also were named: Bob Maurer (two years), Howard Nordquist (two years), Frank Dolson (one year), Max Zange (one year). Past chairman of the section is Philip H. Smith.

A paper on "Causes of Localized Corrosion" was presented by Dr. R. B. Mears of Carnegie-Illinois Steel Corp. Dr. Mears pointed out localized corrosion frequently is more undesirable than uniformly distributed attack and that some of the most spectacular service failures of metallic equipment are caused by stress corrision cracking which is the result of a special type of localized corrosion. Examples of service failures caused by various localized corrosion factors were given.

•

Next meeting of the Greater St. Louis Section will be held September 18, the third Monday of the month, it has been announced by William F. Gross, secretary. The section plans to hold meetings monthly thereafter on the third Monday.

yes... an oil seal that's tailor-made to *resist* corrosion

● If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

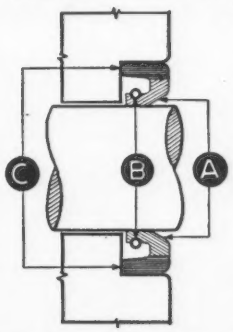
Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼" I.D. up to 66" O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Here's how *Clipper Seal* works:



The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

Johns-Manville **PACKINGS & GASKETS**

Phosphorus Alloys' Corrosion Resistance Cited

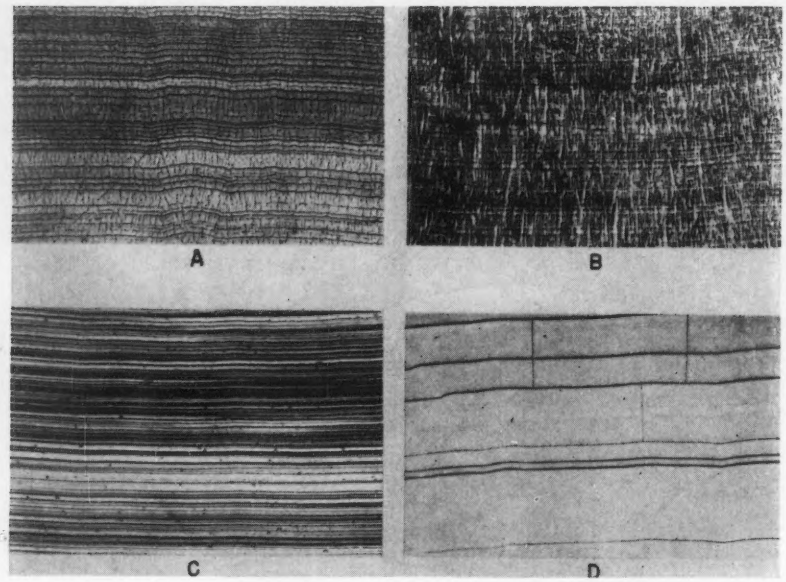


Figure 1—Photomicrographs of alloys of phosphorus with cobalt and nickel electrodeposited by means of a technique developed at the National Bureau of Standards. The low-phosphorus alloys show a columnar structure while the structure of the high-phosphorus alloy is laminated or banded.

A—Low phosphorus nickel (2.3 percent phosphorus);
B—Low phosphorus cobalt (2.2 percent phosphorus);
C—High-phosphorus nickel (13 percent phosphorus);
D—High-phosphorus cobalt (10 percent phosphorus).
Magnification: Approximately X165.

Alloys of phosphorus with cobalt or nickel electrodeposited on metal possess characteristics in some respects superior to pure cobalt or nickel plate, according to Technical Report 1441 of the National Bureau of Standards, Washington, D. C. Alloys with percentages of phosphorus higher than one are highly resistant to corrosion and chemical attack, exceeding in this respect the pure metals. Experiments at the bureau showed nickel alloyed with 10 to 14 percent phosphorus was attacked considerably less by hydrochloric acid than was pure nickel.

Other characteristics of the alloy deposits were given as follows:

1. Some phosphorus alloys when immersed momentarily in a solution of an oxidizing agent, such as ferric chloride, or made anodic in the plating bath, formed a jet black film on the surface. This hard, adherent film has possibilities for decorative use.

2. Photomicrographs show the low-phosphorus alloys have a columnar structure and high-phosphorus alloys a laminated or banded structure. X-ray diffraction patterns of high-phosphorus alloys show no crystalline structure. When heat treated the deposits develop a fine-grained structure instead of large crystals characteristic of pure nickel or cobalt.

3. The pleasing appearance, ease of deposition, hardness and corrosion resistance of the new alloys suggest their use for gages, cylinder walls, piston rings and other machine parts where resistance to wear is important.

4. Appearance depends on phosphorus content. Those with less than 2 percent phosphorus usually are smooth with a mat finish, but as the percentage of phosphorus increases they become brighter, reaching a peak at about 10 percent.

(For further details see: Electrodeposition of Alloys of Phosphorus and Cobalt or Nickel by Abner Brenner, Dwight E. Couch and Eugenia Kellogg Williams, *J. Res. NBS*, 44, 109 (1950) RP2061.)

NACE Memberships For Half Year Offered

Effective July 1, membership in the National Association of Corrosion Engineers for the last half of 1950 may be taken out by interested persons at $5 for the six months' period. All privileges of membership will accrue except issues of CORROSION for the first six months of the year will not be provided. Those joining for the half year, however, may secure available extra copies at the membership rate if desired.

Requests for applications, and applications for membership should be addressed to Central Office, stipulating that the applications are for the last half of the calendar year 1950, namely for the period July 1-December 31, 1950, inclusive. The $5-per-half-year provision does not apply to any other period except the last half of the calendar year 1950 and no exceptions are authorized, it was emphasized.

April Issues of Corrosion Are Needed

Copies of the April, 1950, issue of CORROSION not needed by members of the association or by subscribers will be welcomed by Central Office. Fifty cents per copy will be paid to all who return them to NACE, 919 Milam Bldg., Houston 2, Texas. An unprecedented demand and large number of new members during the first half of the year have depleted stock of the issue.

NACE CALENDAR

LOS ANGELES SECTION—August 16.

TP1-A PACIFIC COAST—Meets monthly.

CORPUS CHRISTI SECTION—Meets fourth Wednesdays monthly.

Desirable Qualities of Phosphoric Acid As Scale Remover, Inhibitor Are Given

Five percent phosphoric acid solution, boiling at atmospheric pressure, gave good deposit removal and negligible attack of metal and a surface resistant to rusting in boiler cleaning experiments conducted by T. E. Purcell, general superintendent of power stations, and S. F. Whirl, chief chemist, power stations department, Duquesne Light Co., Pittsburgh, Pa. This data was reported by the authors to the semi-annual meeting of the American Society of Mechanical Engineers at Hotel Statler, St. Louis, June 22. The inhibited phosphoric acid removed rust and mill scale from new boilers and water-formed insoluble deposits from serviced units without the limitations and adverse effects associated with inhibited hydrochloric acid, the authors claimed.

Advantages of the phosphoric acid boiler treatment mentioned by the authors included:

1. It can be boiled in the unit by direct firing with negligible attack on the metal because the inhibitor is effective at these temperatures.

2. Resulting natural circulation from direct firing promotes distribution, even into regions of the boiler which otherwise could not be reached except by recirculation with elaborate internal baffling.

3. Phosphoric acid is more stable than hydrochloric, which eliminates the corrosive and noxious fumes of the latter acid. Boiler areas subject to vapor attack above the level of the cleaning solution are subjected to the corrosive effect of uninhibited hydrochloric acid because the ihibitor remains in solution.

4. No corrosive fumes are emitted to attack plant equipment.

5. Phosphoric acid leaves a rust-resistant surface, while surfaces cleaned by hydrochloric acid have a tendency to after-rusting.

Electrochemical Society Officers Are Named

Dr. Charles L. Faust, head of electrochemical engineering research at Batelle Institute, Columbus, Ohio, has been named president of the Electrochemical Society. Other officers named by the society are Dr. Ralph M. Hunter, manager of Dow Chemical Company's electrochemical division, and Dr. J. C. Warner, president-elect of Carnegie Institute of Technology, vice-presidents; Dr. Henry B. Linford, associate professor of chemical engineering at Columbia University, secretary, and E. G. Widell, RCA-Victor Division, Radio Corporation of America, treasurer.

Dr. Faust has been a pioneer in development of electropolishing.

Anodes Approved for Mothball Fleet Tests

Graphite anodes for Maritime Commission ships tied up at docks where electric power is available (2 vessels) and magnesium anodes for 2000 afloat elsewhere were found to be best for protecting the ships against corrosion by use of cathodic protection systems, it was reported in the March 27, 1950, issue of *Steel*. Anodes buried in damp earth or sand work just as well as those in salt water, the commission's investigations have indicated tentatively. The $2,200,000 requested for protecting the ships during the fiscal year beginning July 1 has not been appropriated by Congress.

Hamilton Will Assist In Conference Work

Hugh L. Hamilton of Keystone Pipe Line Co., Philadelphia, has accepted the post of assistant general chairman of the 1951 NACE Conference and Exhibition, it has been announced by L. B. Donovan, general chairman.

Detailed plans are rapidly taking shape for the meeting March 13-16, 1951, at Hotel Statler, New York City.

Corpus Christi Meets

John Nee of Briner Paint Manufacturing Co. presented a talk entitled "Protective Coatings for Industry" at the May 24 meeting of Corpus Christi Section at the Princess Louise Hotel. A film, "The Formica Story," was presented by Jack Breslin of the Formica company.

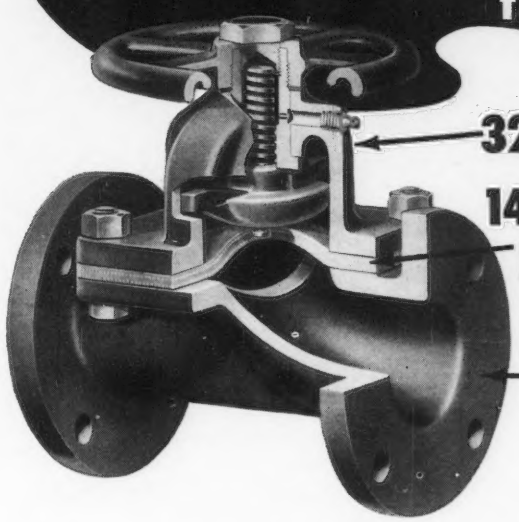
●

Copies of preprints of the St. Louis Conference paper, "Corrosion Problems Related to Air Transport Aircraft," by O. E. Kirchner and F. M. Morris of American Airlines, Inc., may be had on application to Central Office for the cost of packing and shipping, 25c. The preprints were supplied by the engineering department of American Airlines without cost to NACE.

Hills-McCanna offers

Over 20,000

different assemblies for valving "hard-to-handle" fluids



All the various possible combinations of bonnet assemblies, diaphragms and body materials available in Hills-McCanna valves total over 20,000! True, many of the combinations would not be practical, but this figure does indicate the tremendously wide variety of valves that Hills-McCanna offers. No matter how specialized your problem of valving corrosive and/or hazardous substances, slurries, viscous liquids, gases, fermentation products, materials subject to coagulation, foods or beverages, the chances are that Hills-McCanna can furnish the proper valve to meet your needs.

Hills-McCanna valves are Saunders patent diaphragm valves wherein the closure is affected by pressing a resilient diaphragm against a transverse weir. Working parts are isolated from the flow. The valve is leak-tight and requires no packing. Sizes from 3/8" to 14".

Write, today, for full information and descriptive literature, HILLS-McCANNA CO., 2341 W. Nelson St., Chicago 18, Ill.

HILLS-McCANNA

Saunders patent diaphragm valves

Proportioning Pumps

Force-Feed Lubricators • Magnesium Alloy Castings

BOOK REVIEWS

"THERMODYNAMICS OF DILUTE AQUEOUS SOLUTIONS WITH APPLICATIONS TO ELECTROCHEMISTRY AND CORROSION"

By M. J. N. Pourbaix, University of Brussels, Belgium, translated by J. N. Agar and with a foreword by U. R. Evans. Edward Arnold and Co., London, 1949. (U. S. distributors: Longmans, Green and Co., Inc., 55 Fifth Avenue, New York). xv + 136 pages, 27 figures, $5.50.

The publication in English of Dr. Pourbaix's fundamental work on potential-pH diagrams and their applications will no doubt be most welcome in corrosion circles. The first presentation in English of the applications of these potential-pH diagrams to corrosion was published in CORROSION, 5, 121-133 (1949) under the title "Corrosion, Passivity and Passivation from the Thermodynamic Point of View." This article as well as the oral presentations by Dr. Pourbaix during his visit to the United States in the summer of 1949 have shown the need for a more complete treatment.

The book now made available in English is a translation of the doctoral thesis presented by Pourbaix at the Delft Institute of Technology, The Netherlands, in 1945 which was first published in French by Meinema at Delft and by Béranger at Paris. The separate portfolio of figures of the French book is now replaced by figures in the middle of the text. This renders the examination of the figures considerably easier but an attractive feature of the earlier figures has been lost, namely the graded shading of certain areas of the diagrams indicating gradual concentration changes. Before the last war Pourbaix had already published several articles concerning these diagrams in various Belgian and French technical journals.

After brief but clear summaries of the theories of homogeneous, heterogeneous and electrochemical equilibria, including an analysis of the role of potential and of pH, the author presents the essentials of the theory and of the construction of potential-pH diagrams for the systems consisting of an element, water and all the ions, oxides, hydroxides, etc. which can be formed through interaction between the element and water. He defines the domains of stability of the various species. In particular, with metals, domains of corrosion, of passivity and passivation are established, the boundaries between these domains corresponding to selected values of the concentrations of ions in equilibrium with the solid phases. The fundamental consequences from the point of view of corrosion are made quite evident. Diagrams are presented for copper, iron, chromium and also for nitrogen.

Although these diagrams are based upon thermodynamic equilibrium data and the consideration of reversible transformations their usefulness is not thereby limited. They give the general frame within which corrosion reactions can take place and they can be used as guides in the investigation of irreversible conditions through polarization curves, through overvoltage experiments, etc. The diagrams also bring out clearly the connection between cathodic protection and the chemical processes of corrosion.

Dr. U. R. Evans and his collaborators at Cambridge University were quick to recognize the fundamental nature of Pourbaix's work. Dr. Evans has repeatedly called attention to Pourbaix's writings and has written, for the present volume, a most enthusiastic foreword.

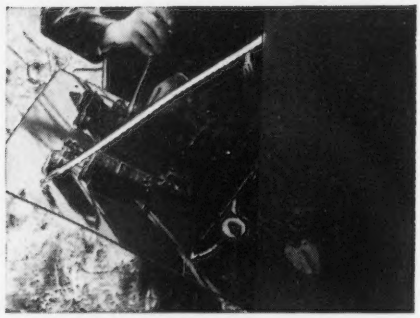
The need for a complete collection of potential-pH diagrams is apparent and it is to be hoped the publication of the many other diagrams already prepared by Pourbaix and a few collaborators will prove feasible in the near future.

The book, although small in appearance for its price, is strongly recommended to all persons interested in corrosion, whether their occupation be research or any of the many phases of corrosion prevention and control.—Pierre Van Rysselberghe, University of Oregon, Eugene, Oregon.

"Application Designed"

CONTROL'S
Cathodic
Protection
Rectifier Offers . .

EASY, ONE-MAN INSPECTION and maintenance . . . lower cost cathodic corrosion protection . . . for storage and distribution installations buried in soil, submerged in liquid or above ground.



ONE MAN CAN EASILY AND QUICKLY remove Control Corporation's type of swinging Rectifier panel for cleaning, repair or to replace any one of the seven interchangeable panels with a higher or lower capacity rating. Control's self contained Rectifier panels permit fast and inexpensive changing of rectifier assemblies.

Write Dept. C for new JA-3 Bulletin

CONTROL CORPORATION
717 CENTRAL AVE. N.E. MINNEAPOLIS 14, MINN.
• Super-Trol • Peak-Trol • Telemetering • Battery Chargers • Carrier Current •

the Silent Watchman

DIXIE TANK and BRIDGE CO.

3523 Lamar Ave.—P. O. Box 14, MEMPHIS 1, TENNESSEE

Complete Service for Elevated Water Tanks—

NATION WIDE SERVICE—

32 Years Experience

KEEP THE SAFETY FACTOR IN YOUR TANK THE DIXIE WAY

By welding seams, pits and rivets which gives a riveted tank 15% more Safety Factor than it had when built. No rivets removed, water supply maintained while work is in progress.

On completely re-conditioned jobs, the painting is guaranteed for five years, repairs guaranteed for ten years, provided the tank is painted every five years. Yearly inspection, making all adjustments, if any, without additional cost.

Write Us for Free Copy of Publication

SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK
by W. A. Riley

DIXIE'S NATION WIDE SERVICE SATISFIES

Copyright 1949

THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

MEMBERSHIP CARDS AVAILABLE

Association members in good standing will be issued on request a membership card in the National Association of Corrosion Engineers. Address requests to A. B. Campbell, Executive Secretary, 919 Milam Building, Houston 2, Texas.

Corrosion Problems

Questions and answers for this heading should be submitted in duplicate if possible, addressed to "CORROSION PROBLEMS", National Association of Corrosion Engineers, 919 Milam Building, Houston 2, Texas. Questions received at the address above above will be sent to E. A. Tice, The International Nickel Co., Inc., N. Y., who is acting editor of the page. All questions will become property of NACE. Questions and replies may or may not be published under this heading and may be answered either by mail directly to the person asking the information, or published under this heading, or both, at the discretion of the editorial staff. Answers to published questions are solicited. Authors of questions will remain anonymous to readers, while authors of answers may remain anonymous if they request it.

No. 38—On a gasoline tank farm or terminal, where tank bottoms and underground pipe lines are cathodically protected by means of rectifiers, what fire hazards exist during loading and unloading of transport trucks, tank cars or tankers? Should rectifiers be turned off when loading or unloading? Should all lines to docks and loading racks be insulated from lines under protection?

ANSWER

As to the fire hazards that exist between a loading system under cathodic protection and loading or unloading trucks, tank cars, and tankers, I would say that the answer to this question could only be found by making a number of instrument observations in the field in order to determine the magnitude of current flow that would be established between the cathodically protected structure and the vehicle whenever the two are brought into intimate contact. This would be the only sure way to settle this question for any local conditions and circumstances.

Rectifiers should be turned off when loading or unloading if the foregoing described observations should reveal the danger of a spark being produced during such operations.

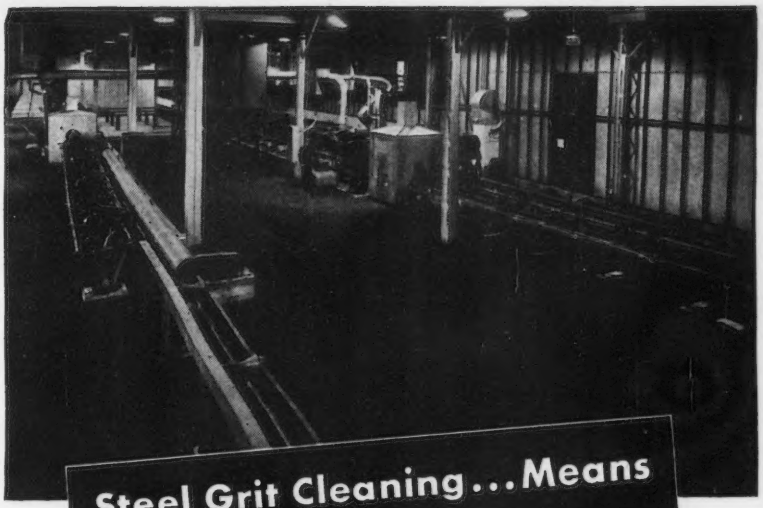
The decision to insulate all lines to docks and loading racks from lines under cathodic protection can only be determined by making instrument observations on these structures. It is impossible to make a general recommendation along these lines because obviously, the local circuit conditions vary from place to place.—W. E. HUDDLESTON, Huddleston Engineering Co.

●

No. 42—Can someone cite examples to show that corrosion products formed in crevices may exert considerable thrust? In the case of sectional cast iron boilers used in domestic heaters some evidence has been found to indicate that corrosion products create sufficient thrust to cause leaks at the nipple joints in such sections, despite the use of stay bolts. Considerable rust has been observed on contacting surfaces which normally butt together. Could such products exert a force strong enough to cause leaks to develop?

ANSWER NO. 1

Evidence of the thrust exerted by corrosion products on steel are mentioned in two recent



Steel Grit Cleaning...Means Better Bond of Coating by standard pipeprotection inc.

STEEL GRIT... used in two Wheelabrator cleaning machines, provides the ideal method of cleaning all your pipe... every joint... a positive method of removing all mill scale and rust.

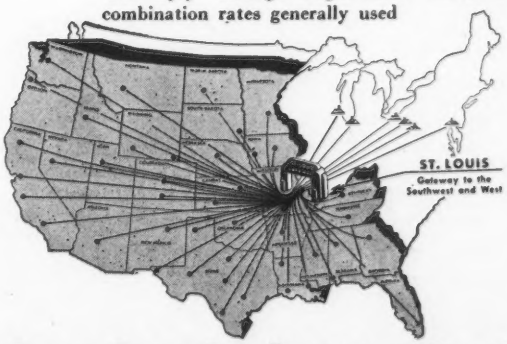
In evaluating the bond of protective coatings to metal surfaces ... the outstanding metal working industries rate steel grit as 100% efficient, while other methods tend to polish the surface and reduce bond performance.

Pre-warming and drying of pipe before cleaning and priming ... are a part of the Standard Procedures established by ***standard pipeprotection inc.*** to bring you uniform coatings of the highest quality, at no increase in cost.

STORAGE-IN-TRANSIT... You can store your pipe in our yard up to 12 months without freight penalty... while determining final destinations... Through freight rates via our Saint Louis plant and our storage facilities save you money.

Wire, Phone or Write Now for Schedules

Immediate shipment or stop-over up to 12 months is permitted under existing railroad tariffs. When you ship your pipe through the Saint Louis Gateway... You enjoy "through freight rates" instead of higher combination rates generally used



standard pipeprotection inc.

3000 South Brentwood Blvd. • St. Louis 17, Missouri

Corrosion Problems—

articles and the reader is referred to them for more details.

a) "Electrolytic Corrosion of Steel in Concrete" by G. M. Magee, *Corrosion*, Nov. 1949 p. 378.

b) "Corrosion Characteristics of Concrete River Clamps" *World Oil*, 128 No. 10, 170 (1949) Feb. 1.

ANSWER NO. 2

An example of the effect of thrust of corrosion products in a crevice in a riveted joint of 17ST aluminum was described, Figure 7, in the article, "Designing to Prevent Corrosion" by R. B. Mears & R. H. Brown, *Corrosion*, Vol. 3, No. 3, March, 1947.

No. 51—In farm equipment we are faced with the problem of corrosion of cast iron fertilizer hopper parts when fertilizers such as ammonium sulfate, nitrate of soda and urea are used. These materials corrode sufficiently to freeze the hopper parts, which leads to breakage. Are there available reasonably priced alloyed cast irons or other metals which can be used in this service to overcome this problem?

No. 52—In regard to vanadium in fuel oils used for firing boilers:
a) Has the oil residue containing vanadium any deleterious effect on on the steel work or refractories?
b) If so, what is the maximum amount of vanadium tolerable?
c) How can vanadium best be detected in fuel oils?
d) How can it best be eliminated?

anti-corrosive strapping and seals

7 Metals and Finishes

Strapping designed to last the lifetime of the insulation.

Available types:
MONEL COPPER
BRASS ALUMINUM
STAINLESS—TYPES 304 and 316
GALVANIZED STEEL

Also Tools for application.

FREE
Handy calculator—one side tells you which strap to use for any given corrosive condition; other side determines length and weight of strap required for any binding operation.

A. J. Gerrard & Co.
1952 Hawthorne Ct., Melrose Park, Ill.
(Chicago Suburb)
SM-3

Seven Technical Sessions Held June 7-9 by Sea Horse Institute

Seven three-hour technical sessions and inspections left little time for recreation at the Sea Horse Institute's Wrightsville Beach, North Carolina, June 7-9, 1950, meeting. The sessions were attended by 250 members of this organization fostered by The International Nickel Co., Inc. Inspection of the laboratory, museum and test lots occupied most of the time not used for formal sessions.

The program covered in some detail condenser tube alloys, corrosion and protection of cargo spaces in tankers, corrosion and protection of steel piling and slips and coatings to protect metals. Two sessions were devoted to some 20 miscellaneous topics.

The laboratory, museum and sea water immersion tests have been moved to Harbor Island near Wrightsville from Kure Beach. A new laboratory and museum have been built as well as new racks for exposing sample in sea water.

The program for the conference was prepared and directed by F. L. LaQue of International Nickel Co.

Mid-Year Directory Supplement Dropped

No supplementary directory of membership of the National Association of Corrosion Engineers will be published in July this year because of the change of policy effective with the February issue of CORROSION whereby the names of new and reinstated members and the names of members whose addresses have changed are published monthly. It was considered sufficient to provide membership information monthly, principally for the convenience of section and regional officers.

Case Short Course Lecturers Named

Lecturers who are scheduled to participate in the Case Institute of Technology short course on corrosion tentatively scheduled to begin September 25 were named as follows by R. B. Hoxeng, of the institute, who has general supervision of arrangements: F. L. LaQue of The International Nickel Co., Inc., New York; R. B. Mears of Carnegie - Illinois Steel Corp., Pittsburgh, Pa.; Mars G. Fontana, Ohio State University, Columbus, Ohio and Harold A. Robinson, The Dow Chemical Co., Midland, Mich.

OBITUARY

BRUCE L. COREY

Funeral services were held June 14, 1950 to Topeka, Kansas for Bruce L. Corey, a member of NACE, who died from injuries suffered in an automobile accident 13 miles east of Topeka Sunday, June 11 at 1 p.m. Mr. Corey was en route to a job for Socony-Vacuum Oil Company, his employers for the past 15 years. He succumbed at 2:45 a.m. Monday, June 12. Survivors include a widow and an unmarried daughter.

Clippings on Corrosion

Extracted from Current Periodicals

SAFETY STRESSED IN GAS LINE LAID IN NEW YORK CITY

(From New York Times, May 7, 1950)

A safety factor of 5 has been incorporated into the natural gas pipe line laid from the Brooklyn Borough Works delivery point through the Metropolitan New York area. The line, designed for 350 psi, is coated with enamel and wrapped with fiber glass and asbestos. Cathodic protection is supplied by magnesium anodes with a design life of 15-20 years.

Added safety incorporated into the line includes forged bends for all curves over 12 percent; steel valves, greater pipe thickness than ASA code requirements.

Sections of the line were laid under supervision of Brooklyn Borough Gas Co., Kings County Lighting Co., Long Island Lighting Co., Brooklyn Union Gas Company, Consolidated Edison Co. of New York. The line continues eastward out of Queens to Long Island Lighting Co.

•

DRIED SALT CALLED CAUSE OF OUTBOARD MOTOR RUST

(From Milburn, N. J., Item, Apr. 27, 1950)

"Today's outboard is built for strong use. Manufacturers have selected the most durable metals for making their products, but it can't be said that continual exposure to salt water is beneficial to bronze, steel or aluminum alloys, especially after a motor is removed from salt water, then left to dry out in fresh air until, finally, the particles of salt crystallize, inviting rust and corrosion."

•

PHOSPHATE PRE-TREATMENT PROCESS IS REVEALED

(From Omaha, Neb., Unionist, May 4, 1950)

A method of phosphate pre-treatment of large objects without immersion has been developed by A-S Den Kemiske Fabrik Norden in Oslo, Norway. The method involves use of a proprietary compound called Caphos, a white powder, which is mixed with water in the ratio of one pound of powder to 4/5-pint of water. The mixture is then applied to the surface of iron where it is said to combine with corrosion products to form into phosphate and to otherwise affect the metal surface so that corrosion is inhibited. Successful experimental use of the material in the protection of submerged objects or objects in a humid environment is claimed.

Instrument Society to Meet in Houston, Texas

The 1951 Instrument Society of America national conference and exhibit will be held September 10-14 at the Coliseum, Houston, Texas. W. H. Fortney, instrument foreman at Humble Oil and Refining Company's Baytown refinery, member of the Houston ISA section, is chairman of the arrangements committee. The Houston meeting will be the first held west of the Mississippi river.

NACE
NEW AND REINSTATED MEMBERS
AND ADDRESS CHANGES

NEW AND REINSTATED MEMBERS

(Changes Through May 26, 1950)

CALIFORNIA

BARNHILL, I. HARRY, Public Housing Administration, 760 Market St., San Francisco 2, California.
BROWNE, JOHN J., General Petroleum Corp., P. O. Box 726, Wilmington, California.
DEAN, LYLE A., Route 1, Box 119, Walnut Creek, California.
KIRKENDALL, WILLIAM E., Dep't. of Water & Power, 501 East Second, Los Angeles, California.
SIEVERT, M. A., Reynolds Metals Co., 260 Bendix Bldg., 1206 S. Maple St., Los Angeles 15, California.
SMITH, BERTRAM M., Metallizing Engineering Co., Inc., 1206 Maple Ave., Los Angeles 15, California.
YOUNGER, A. M., Younger Co., 2166 Market St., San Francisco, California.
WARD, THOMAS W., Amercoat Corp., 4809 Firestone Blvd., South Gate, California.

COLORADO

BECKER, HENRY K., Wyco Pipe Line Co., Box 2388, Denver 1, Colorado.

CONNECTICUT

BLOCH, PETER K., Branson Instruments, Inc., 436 Fairfield Ave., Stamford, Connecticut.
NEWELL, I. LAIRD, The Henry Souther Engineering Co., 11 Laurel St., Hartford 6, Connecticut.
SCHMID, CHARLES F., The Kerite Co., 49 Day St., Seymour, Connecticut.

FLORIDA

WHIDDEN, IRA, Rader Knappen Tippetts Engineering Co., 1615 Du Pont Bldg., Miami 32, Florida.

ILLINOIS

DUFFNER, GORDON H., 1749 E. 83rd St., Chicago 17, Illinois.
FEEN, GEORGE P., Sales Development Div., Caterpillar Tractor Co., Peoria, Ill.
JANOTA, RUDOLPH B., Swift & Co., Research Laboratories, Chicago 9, Illinois.
KILBERG, BERNARD, Deere & Co., Moline, Illinois.
KROON, HARRY E., Illinois Bell Telephone Co., 1025 Sunnyside, Chicago, Illinois.
MORI, JOHN Y., U. S. Steel Supply Co., 1319 Wabansia Ave., Chicago 22, Illinois.
PHILLIPS, KENNETH A., American Zinc, Lead & Smelting Co., P. O. Box 495, East St. Louis, Illinois.
REED, CLYDE L., Wilson & Co., Inc., 4100 So. Ashland Ave., Chicago 28, Illinois.
STROTHMAN, E. P., 310 South Michigan Ave., Chicago 4, Illinois.
WEART, JAMES G., Illinois Dept. of Public Health, State House, Springfield, Illinois.

INDIANA

JORDAN, PHILIP R., American Wheelabrator & Equip. Corp., 400 South Byrkit, Mishawaka, Indiana.
SWANN, J. S., Standard Railway Equipment Mfg. Co., 4527 Columbia Ave., Hammond, Indiana.

IOWA

BIELENBERG, ARTHUR C., Iowa-Illinois Gas & Electric Co., 2nd & Perry, Davenport, Iowa.

LOUISIANA

MARTIN, JACK T., The Texas Co., Box 951, Houma, Louisiana.
SCHUTT, RUSSELL W., Shell Oil Co., Box 595, Franklin, Louisiana.
SEARCY, JOHN E., Jr., United Gas Pipe Line Co., P. O. Box 1407, Shreveport, Louisiana.

MICHIGAN

CRAMER, ANTHONY H., Michigan-Wisconsin Pipe Line Co., 500 Griswold St., Detroit 26, Michigan.
MAHER, D. W., Minnesota Mining & Manufacturing Co., 411 Piquette Ave., Detroit 2, Michigan.
MILLER, DWIGHT L., Sharples Chemicals, Inc., Wyandotte, Michigan.

(Continued on Next Page)

UNIFORM HIGH QUALITY

Pipe protection can be "pedigreed," too.

There's no chance for variation in the quality of cleaning, priming, coating and wrapping you get at Pipe Line Service. Precision equipment, developed by PLS engineers out of long experience, guarantees uniformity of pipe protection every step of the way.

This *controlled* service is provided by skilled personnel working *inside* PLS plants to give you more for your money in pipe protection of consistent, high quality.

PLS

PIPE LINE SERVICE CORPORATION
Pioneers in Steel Pipe Protection
General Offices and Plant: Franklin Park, Illinois
Plants at Glenwillard, Penna.; Longview, Texas; Corpus Christi, Texas; Harvey, La.; Sparrows Point, Md.

CORROSION DIRECTORY

Rates for notices under this heading can be obtained from National Association of Corrosion Engineers, 919 Milam Building, Houston 2, Texas

STARR THAYER
Consulting Engineer
Corrosion mitigation on existing structures; protection designed for new structures.
614 S. Standard Bldg. Houston, Texas

STATIONARY COATING & WRAPPING
COMPLETE PIPE RECONDITIONING
Plants – Corpus Christi – Refugio, Texas
Jackson, Miss.
ROSSON-RICHARDS CO.
Box 908–Corpus Christi–Ph 3-5121 & 2-9021
Portable Units Available for Rail-Head Coating Anywhere

South Florida Test Service
INSPECTION – TESTING – RESEARCH ENGINEERS
(Established 1931)
Corrosion, weathering and sunlight tests. Four locations in Southern Florida for inland, salt atmospheric, tidewater and total immersion exposure tests.
4201 N. W. 7th St. MIAMI, FLORIDA

SERVING ALL PIPELINES
PIPELINE ASBESTOS FELT
Made by The Ruberoid Co.
COAL TAR ENAMEL COATINGS
Made by Pittsburgh Coke & Chem. Co.
"Steve" Day
S. D. DAY COMPANY
2017 W. Gray Houston 19, Tex.
Phone KE-0407

RESEARCH PRODUCTS FOR SOLVING PROTECTIVE COATING PROBLEMS
Product Development | Application Engineering
SPECIALTY COATINGS LABORATORY
1721 North Water Street
MILWAUKEE 2, WISCONSIN

Cathodic Protection Service
Engineering – Installation – Surveys
Material – Supplies
Everything in the Cathodic Protection Field from an Insulating Washer to a Turnkey Contract Installation
HOUSTON 4601 Stanford Ph JA-5171 | TULSA 310 Thompson Bldg. Ph 2-9857

Complete
CATHODIC PROTECTION
Systems . . . supplies . . . service for special applications; water tanks and pipe lines.
HARCO CORPORATION
2154 East 4th St. Cleveland 15, Ohio

Cathodic Protective Systems Designed and Installed
Coating and Laying Specifications; Corrosion Surveys; Consultation On All Types of External Pipe Line Corrosion.
Huddleston Engineering Co.
Bartlesville Oklahoma

• SALES • INSTALLATION
Federated Magnesium Anodes – Cadwell Welding Supplies
F. H. Maloney Insulating Materials
Complete line of Cathodic Protection Equipment
Pipeline Maintenance Corporation
811 So. Boulder Phone 3-0846
TULSA, OKLAHOMA

PIPE COATING "KNOW-HOW"
by PIPE PROTECTION SERVICE, Inc.
Modern Portable Railhead Equipment for Any Size Pipe or Job
Main Plant: 179 FRONT ST., ELIZABETH, N.J.
"The Complete Coating Service"

CATHODIC PROTECTION
Surveys Engineering
Installation Maintenance
Electro Rust-Proofing Corp. (N. J.)
BELLEVILLE 9, NEW JERSEY
Atlanta – Chicago – Dallas – Monrovia

A. R. FOX
Corrosion Engineering Service
Cathodic Protection - Non-Destructive Testing
Special Investigations
Miscellaneous Instruments & Supplies
3405 Piedmont Ave.
Oakland 11, Calif.

IF YOU SELL A CORROSION SERVICE
YOUR AD BELONGS HERE

CATHODIC PROTECTION
Installation Maintenance Sales
TURNKEY INSTALLATIONS
Dowell Magnesium Anodes or Material to Your Specifications
ANODE ENGINEERING CO.
P. O. Box 3355 TULSA, OKLA.

New Members–

(Continued from Page 9)

REED, JOHN W., Saran Lined Pipe Co., 70 Stephenson Bldg., Detroit 2, Michigan.

MISSOURI

HARTMAN, LOWELL S., Hartman-Hanks-Walsh Painting Co., 4903 Delmar Blvd., St. Louis 8, Missouri.
O'CONNELL, FRANK D., Contibu of St. Louis Inc., 7836 Manchester Ave., St. Louis 17, Missouri.
WALSH, MARTIN P., Hartman-Hanks-Walsh Painting Co., 4903 Delmar Blvd., St. Louis 8, Missouri.

NEBRASKA

OLSON, THEODORE W., Box 486, Beatrice, Nebraska.

NEW JERSEY

BERGER, HENRY G., Socony Paint Products Co., Metuchen, New Jersey.
FASIG, PAUL L., 173 LEEDS PLACE, Woodbury, New Jersey.
KAHLER, LEROY P., Joseph Dixon Crucible Co., Wayne & Monmouth Sts., Jersey City 3, New Jersey.
McWHORTER, SAM B., 7 Poe Ave., New Brunswick, New Jersey.
WOODWARD, WM. N., De Laval Steam Turbine Co., Trenton 2, New Jersey.

NEW YORK

BOLL, HARRY J., American Machine & Foundry Co., 5502 Second Ave., Brooklyn 20, New York.
GARDNER, KARL A., Griscom-Russell Co., 285 Madison Ave., New York 17, New York.
HOYT, W. B., The M. W. Kellogg Co., 225 Broadway, New York 7, New York.
JOECKS, ADOLPH K., Consolidated Edison Co. of New York, Inc., 708 First Ave., New York, New York.
KROCHMALSKI, EDWARD, Corning Glass Works, Corning, New York.
STIVALE, JOSEPH J., Brooklyn Varnish Mfg. Co., Inc., 50 Jay St., Brooklyn 1, New York.
TREBLER, H. A., National Dairy Research Laboratories, Inc., Oakdale, Long Island, New York.

NORTH CAROLINA

JOHNSTON, THOMAS A., Jr., Aluminum Company of America, 616 Johnston Bldg., Charlotte 2, North Carolina.

OHIO

BUNDY, ALFRED D., Industrial Rayon Corp., W. 98th St. & Walford Ave., Cleveland, Ohio.
LANG, ALBERT A., Pioneer Alloy Products Co., 16601 Euclid Ave., Cleveland 12, Ohio.
LAWRENCE, J. C., The Lexington Supply Co., 4815 Lexington Ave., Cleveland, Ohio.
SANDEL, WALTER J., Coatings for Industry, Inc., 1242 Hall Ave., Lakewood 7, Ohio.

OKLAHOMA

SIDWELL, C. V., 2223 E. 24th St., Tulsa 4, Oklahoma.

PENNSYLVANIA

COLEMAN, WM. E., Carnegie-Illinois Steel Corp., 234 Atwood St., Pittsburgh 13, Pennsylvania.
MENSCH, RALPH G., Pittsburgh Coke & Chemical Co., 1901 Grant Bldg., Pittsburgh, Pennsylvania.
MILLS, JAMES L., Box 233, Rouseville, Pennsylvania.
MILLS, RICHARD P., Freedom-Valvoline Oil Co., Third Ave., Freedom, Pennsylvania.
PARKER, KENNETH B., American Telephone & Telegraph Co., Long Lines Plant Dept., 506 Bourse Bldg., Philadelphia 6, Pennsylvania.
ROYSTON, LOUIS G., Roynston Laboratories, Inc., First St., Blawnox, Pennsylvania.
TINNEY, THOMAS B., Philadelphia Gas Works Co., 31st & Passyunk Ave., Philadelphia 45, Pennsylvania.
URBANEK, JOSEPH P., QM Res. & Dev. Labs., Phila., QM Depot, 2800 South 20th, Philadelphia 45, Pennsylvania.

(Continued on Page 12)

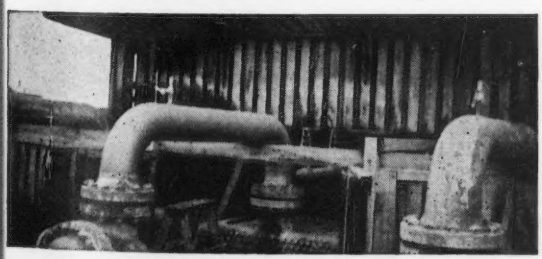
Now! A Better, Easier way to protect Pipe from CORROSION

it's **Polyken®** NO. 882 and NO. 888
CORROSION PROTECTION COATING

JOB-TESTED* FOR

- **field joints** on yard coated pipe
- **repairing** holidays
- **covering** corrosive "hot spots"
- **reinforcing** side, sag, and overbends
- **coating** small diameter pipe

*Underground. POLYKEN No. 882 (black) being applied to joint in field.



*Aboveground. POLYKEN No. 888 (aluminum) coating on exposed pipe at compressor station.

A Single Versatile Material . . . combining these advantages

- It's an oriented polyethylene film (in rolls)
- Applied cold . . . *in seconds!*
- 10,000 volts dielectric strength
- Insulation Resistance: greater than 8 x 10^6 megohms
- No known solvents for plastic at normal operating temperatures
- Water Vapor Transmission Rate: 0.24 gms per 100 sq. in. in 24 hours continuous immersion
- Protects pipe above or underground

Here's a corrosion protection coating that's *clean, simple* and *permanent!* POLYKEN is an oriented polyethylene film carrying its own adhesive. Complete in itself, it comes in rolls, is quickly, simply applied *permanently* . . . without heat, flame, solvents or greases. Underground, it stands off corrosive elements. Aboveground, it is impervious to weather, solvents and other corrosive forces. When applied, POLYKEN stretches, providing a lasting compression against the pipe.

• • •

WRITE TODAY! For samples and engineering data resulting from job-performance tests, address POLYKEN Industrial Tape, Dept. 12-7, 222 W. Adams Street, Chicago 6, Illinois.

Polyken® INDUSTRIAL TAPE
DEPARTMENT OF BAUER & BLACK
DIVISION OF THE KENDALL COMPANY
222 W. ADAMS ST., CHICAGO 6

New Members—

(Continued from Page 10)

VOLLMER, LESLIE W., Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pennsylvania.

TEXAS

ALLEN, RUSSELL G., Corrosion Equipment Co., 4101 San Jacinto St., Houston 4, Texas.
BROUSSARD, EDWARD A., Gulf Refining Company, Houston Pipe Line Div'n., P. O. Box 1203, Houston 1, Texas.
BROWN, GEORGE F., Standard Brass & Mfg. CMo., K. C. S. & 4th Sts., Port Arthur, Texas.
CARPENTER, DAN H., Tretolite Co., Box 1375, Kingsville, Texas.
CLARKE, RICHARD P., The Atlantic Refining Co., P. O. Box 849, Port Arthur, Texas.
DEAN, JOHN E., Texas College of Arts & Industries, Kingsville, Texas.
FORSHA, WILLIAM D., Cabot Carbon Co., Box 1101, Pampa, Texas.
GUMM, HOWARD W., Houston Industrial Gas Co., 215 N. Roberts, Houston, Texas.
KINLEY, JOHN C., M. M. Kinley Co., P. O. Box 13131, Houston 19, Texas.
KUHN, CYRIL D., TCI & RR Box 159, Houston, Texas.
McKENNEY, WARREN E., James E. Mavor Co., Room 514, M & M Bldg., Houston, Texas.
MERCER, C. L. Engineering Dept., Southwestern Bell Tel. Co., Houston 1, Texas.
OGDEN, JAMES A., Pure Transportation Co., P. O. Box 25-W, Van, Texas.
SMITH, DON C., Gulf Oil Corp., P. O. Box 701, Port Arthur, Texas.
THAYER, OLIN E., National Pipe Coatings, Inc., 614 Southern Standard Bldg., Houston, Texas.
TURNER, GUY C., P. O. Box 964, Houston 1, Texas.
SHEETS, MACON, Nueces Painting Co., Box 4071, Corpus Christi, Texas.
WADE, O. W., Transcontinental Gas Pipe Line Corp., 905 M & M Bldg., Houston, Texas.

TENNESSEE

CLAYTON, HENRY M., Memphis Light Gas & Water Div., P. O. Box 388, Memphis 1, Tennessee.

UTAH

BAXTER, CHARLES V., Salt Lake Pipe Line Co., P. O. Box 117, Salt Lake City, Utah.

VIRGINIA

JONES, JESSE C., Newport News Shipbuilding & Dry Dock Co., Newport News, Virginia.

WISCONSIN

FRIEDEN, ALEXANDER, Pabst Brewing Co., 917 W. Juneau Ave., Milwaukee, Wisconsin.

WYOMING

KRUEGER, LOUIS T., Northern Utilities Co., Box 1091, Casper, Wyoming.

FOREIGN

CANADA

YOUNG, JAMES W., Imperial Oil Co., 1409 Premier Way, Calgary, Alberta, Canada.

BRITISH WEST INDIES

RITCHIE, ROBERT, Trinidad Leaseholds, Ltd., Pointe-A-Pierre, Trinidad, B. W. I.

HOLLAND

VAN OOSTERWIJK, A. R. KOLFF, Laboratorium—Koninklijke Shell, Badhuisweg 3, Amsterdam, Holland.
ZELDERS, DIPLOM ING, HERMAN G., Bibliotheek, Staatsmijnen, Centraal Laboratorium, Geleen, Holland.

CHANGES OF ADDRESS

(Old Address Follows New Address in Parenthesis)

CALIFORNIA

BRYAN, LLOYD International Harvester Co. Agency, P. O. Box 360, Napa, California (H. C. Price Co., Somastic Div'n., P. O. Box 1111, Bartlesville, Oklahoma.
CATES, WALTER H., Consolidated Western Steel Corp., Box 2015, Terminal Annex, Los Angeles 54, California (Consolidated Western Steel Corp., 2015 Terminal Annex, Los Angeles 54, California).
DUNHAM, R. A., 2930 East Fifth St., Long Beach 14, California (Union Oil Company of California, 2930 East Fifth St., Long Beach 14, California).
PENDERGAST, HUGH W., 158 North Arna... Dr., Beverly Hills, California (1315 N... Laurel Ave., Los Angeles 46, California).

COLORADO

PRICE, MARION E., Box 509 Golden, Colorado (Pipeline Protection Co., 926 Equitable Bldg., Denver 2, Colorado).

ILLINOIS

CHURCH, LAURENCE T., Panhandle Eastern Pipe Line Co., 1605 Fayette, Springfield, Illinois (Church, Lawrence T., Panhandle Eastern Pipe Line Co., 1605 Fayette, Springfield, Illinois).
CLANCY, J. J., Koppers Co., 122 South Michigan Ave., Room 2040, Chicago 3, Illinois (122 South Michigan Ave., Room 2040, Chicago 3, Illinois).

LOUISIANA

CREEVY, JOSEPH A., P. O. Box 44, Shreveport, Louisiana (Youngstown Sheet & Tube Co., P. O. Box 44, Shreveport, Louisiana).
NICKERSON, JAMES G., Union Tank & Supply Co., Box 114, Lafayette, Louisiana (1... Calhoun, Houston 3, Texas).

MICHIGAN

O'BRIEN, THOMAS W., R. D. Baker Contractor, Inc., Box 187, Redford Station, Detroit 19, Michigan (Consumers Power Co., 212 Michigan Ave. West, Jackson, Michigan).

NEW JERSEY

DAVIS, EDWIN G., 600 Grove St., Haddonfield, New Jersey (American Telephone & Telegraph Co., 600 Grove St., Haddonfield, New Jersey).

NEW YORK

COYLE, T. G., United Chromium, Inc., 1... East 42nd St., New York 17, New York (United Chromium, Inc., 51 East 42nd St., New York 17, New York).
NICHOLSON, C. T. Niagara Mohawk Power Corp., Office Library, Electric Bldg., Buffalo 3, New York (Buffalo Niagara Electric Corp., Office Library, Electric Bldg., Buffalo 3, New York).

(Continued on Page 14)

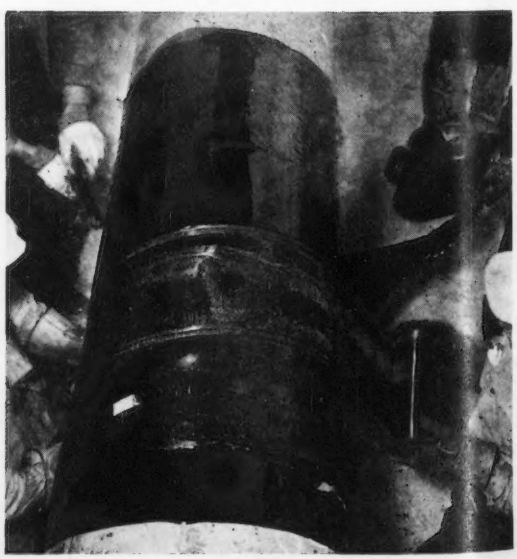
IN CORROSION PROTECTION

Buying the best

ALWAYS COSTS LESS!

Here Glasfab, the permanent reinforcing cloth woven of glass fibers, protects the joints of an underground pipe line.

The open mesh permits full penetration of the bitumin. Glasfab makes this reinforcing job permanent because it is impervious to moisture and is more than 100% stronger than other reinforcing materials.



MANUFACTURED BY:

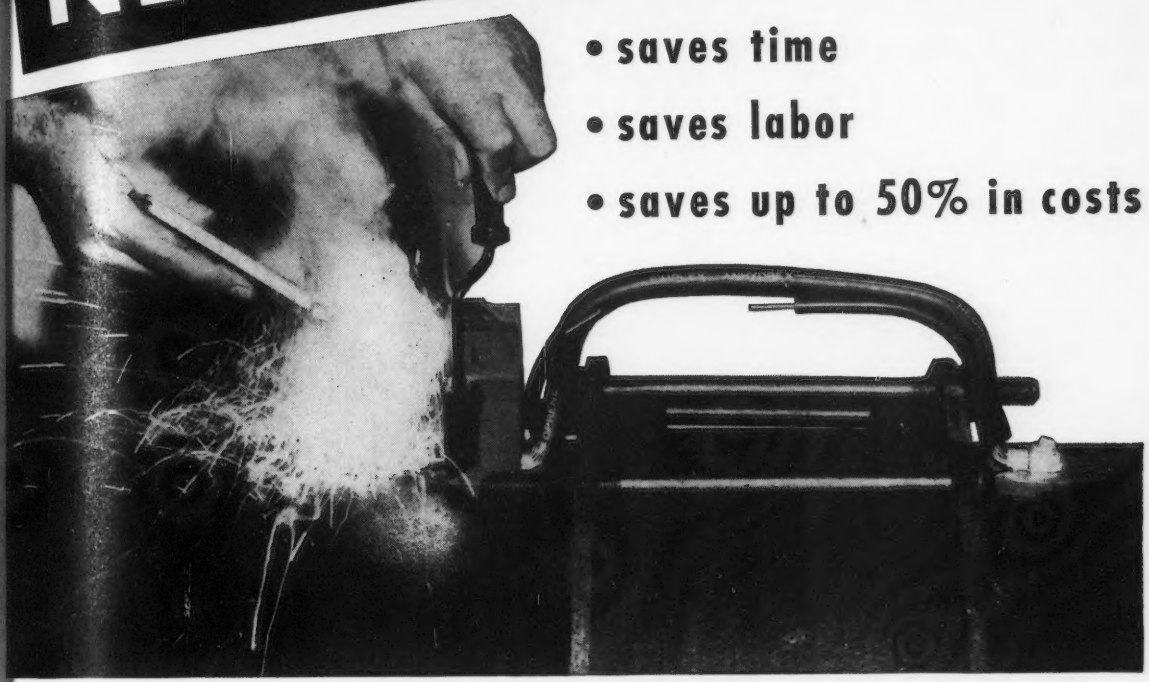
The Lexington Supply Co.

DISTRIBUTED BY:

MIDWESTERN ENGINE & EQUIPMENT CO., INC.

105 NORTH BOULDER Phone 3-4113 TULSA 3, OKLAHOMA

NEW bonding process



- saves time
- saves labor
- saves up to 50% in costs

Corrosion protection is now greatly simplified by new *preformed* Dresser-Bonds and a 5-second chemical welding method that enable any workman to bond mechanical couplings on steel pipelines . . . quickly, easily and at a saving of as much as 50% over previously used bonding methods.

The resistance of the Dresser-Bond is as low as, or lower than, a bond made by any other method. It retains its superior bonding properties permanently because (1) a homogeneous weld area is attained and (2) all surface contact variables are eliminated.

There is no danger of burning the copper wire, pipe or inside pipe coating. No dangerous fumes. No heavy equipment. No training or special skill required. Everything you need for 50 complete bonds is contained in a compact kit which includes *preformed* bonds, chemicals, flint gun and welders.

The neoprene coated 1/0 cable of which Dresser-Bonds are made has been proved for years in underground service.

See the Dresser-Bond installed. Ask your Dresser Sales Engineer to demonstrate it or mail the coupon below for a low-cost trial kit.

DRESSER

MANUFACTURING DIVISION

(One of the Dresser Industries)

Headquarters: Bradford, Pa. Sales Offices: New York, Chicago, Houston, San Francisco. In Canada: Dresser Mfg. Co., Ltd., 629 Adelaide St., W., Toronto, Ontario.

Dresser Manufacturing Division
Bradford, Pa.
Gentlemen:

☐ Send me a complete trial kit of 12 bonds at $32.50.
☐ Have Dresser Sales Engineer call and demonstrate the Dresser-Bond.

Name _____
Position _____
Company _____
Address _____
City _____ State _____

The Liquid Plastic that STOPS CORROSION

PRUFCOAT

can help save your share of this huge bill

*Article in C. & E. News Vol. 27 — #39

PROOF against Acids, Alkalis, Salt, Oil and Water

"Prufcoat proven superior to all other coatings we have tested" . . . writes one of America's largest chemical companies, after eight years' experience with Prufcoat. And this is just one of many reports on file testifying to the effectiveness of Prufcoat's famous liquid plastic formulations in controlling corrosion caused by chemical agents such as these:

Acetic Acid	Muriatic Acid
Alcohols	Nitric Acid
Bleach Solutions	Oleic Acid
Calcium Chloride	Oleum
Chlorine	Phosphoric Acid
Cyanides	Salt Solutions
Formaldehyde	Sugar
Hydrofluoric Acid	Sulfonated Oils
Lactic Acid	Sulphuric Acid
Lubricating Oils	Sodium Hydroxide

Send today for a *Prufcoat PROOF Packet.* Contains in one easy-to-file folio outside laboratory tests, case histories, and Prufcoat Protecto-Graph Plan for analyzing your own painting maintenance costs. *Write Prufcoat Laboratories, Inc., 63 Main St., Cambridge 42, Mass.*

SAVES More because it PROTECTS More

8 Attractive Colors that Apply Like Paint to Masonry, Metal, Wood

New Members—

(Continued from Page 12)

OKLAHOMA

AUDE, T. R., Service Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma).

CARMICHAEL, MILES, Cathodic Servicing Co., 1024 N. Olie, Oklahoma City 6, Oklahoma (1024 N. Olie, Oklahoma City, Oklahoma).

CONDRY, JAMES T., Service Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma).

HUNTER, J. N., Jr., Service Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma).

POLSTON, J. R., Service Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., Box 571, Tulsa, Oklahoma).

SITTEL, V. J., Service Pipe Line Co., P. O. Box 1979, Tulsa 2, Oklahoma (Stanolind Pipe Line Co., P. O. Box 1979, Tulsa 2, Oklahoma).

STIRLING, J. C., Service Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., P. O. Box 1979, Tulsa, Oklahoma).

TEXTER, H. G., Spang-Chalfant Div., Nat'l. Supply Co., 504 East Archer St., Tulsa 3, Oklahoma (Spang-Chalfant Div., Nat'l. Supply Co., Nat'l. Bank of Tulsa Bldg., Tulsa 3, Oklahoma).

PENNSYLVANIA

BYARRE, WM. W., The Atlantic Refining Co., P. O. Box 7709, Philadelphia, Pennsylvania (The Atlantic Refining Co., 260 South Broad St., Philadelphia 2, Pennsylvania).

FLENTJE, MARTIN E., American Water Works Service Co., Inc., 121 South Broad St., Philadelphia 7, Pennsylvania (American Water Works Service Co., 50 Broad St., New York 4, New York)

WRIGHT, EMERSON H., R. D. No. 1, Murrysville, Pennsylvania (P. O. Box 307, R. D. 1, Apollo, Pennsylvania).

TEXAS

BRUYERE, WM. H., Pan American Pipe Line Co., 1413 Niels Esperson Bldg., Houston 2, Texas (Pan American Pipe Line Bldg., 12th Floor, Mellie Esperson Bldg., Houston 2, Texas).

HANES, HENRY W., Box 791, Jacksonville, Texas (United Gas Corp., Jacksonville, Texas).

LOOS, DE LASSO, Cool & Stilley Engineering Co., P. O. Box 574, Midland, Texas (Cool & Stilley Engineering Co., 223 S. Big Spring, Midland, Texas).

SMITH, O. R., Smith Contracting Corp., 205 N. W. 7th, Fort Worth 6, Texas (1410 Ft. Worth National Bank Bldg., Fort Worth, Texas).

SNEDAKER, DELBERT G., 1817 Isabella St., Apt. 1, Houston, Texas (4705 Archer St., Corpus Christi, Texas).

WISCONSIN

BROWN, HAROLD H., 1325 South Mason St., Appleton, Wisconsin (Wisconsin Michigan Power Co., 1325 South Mason St., Appleton, Wisconsin).

FOREIGN

CANADA

DUTTON, W. L., Union Gas Company of Canada, Ltd., 5th St., Chatham, Ontario, Canada (Union Gas Company of Canada, Ltd., 5th St., Chatham, Ontario, Canada).

VENEZUELA

McCAMMON, G. A., Att'n: Technical Library, Creole Petroleum Corporation, Apartado 889, Caracas, Venezuela, S. A. (Dr. F. J. Amador. Att'n: Technical Library, Same Address).

F. J. Amador, Att'n: Technical Library, Same Address).

NEW NACE CORPORATE MEMBERS

New corporate members added in the interval May 15-June 15, 1950, by the National Association of Corrosion Engineers:

ALOX CORPORATION
Niagara Falls, N. Y.
James E. Shields, Representative

CATERPILLAR TRACTOR CO.
Peoria, Ill.
Geo. P. Fenn, Representative

CATHODIC SERVICING COMPANY
Oklahoma City, Okla.
Miles Carmichael, Rep.

DIAMOND ALKALI COMPANY
Painesville, Ohio
C. A. Butler, Jr., Representative

KEYSTONE SHIPPING CO.
Philadelphia, Pa.
S. F. Spencer, Representative

OKLAHOMA GLASS FIBER CORP.
Newport, Arkansas
Earl T. Sheets, Representative

STANDARD RAILWAY EQ. MFG. CO.
Hammond, Ind.
J. S. Swann, Representative

WOLVERINE TUBE DIVISION
Decatur, Alabama
E. A. Wright, Representative

Federated first for Magnesium Anodes

Only Federated gives you magnesium anodes with:

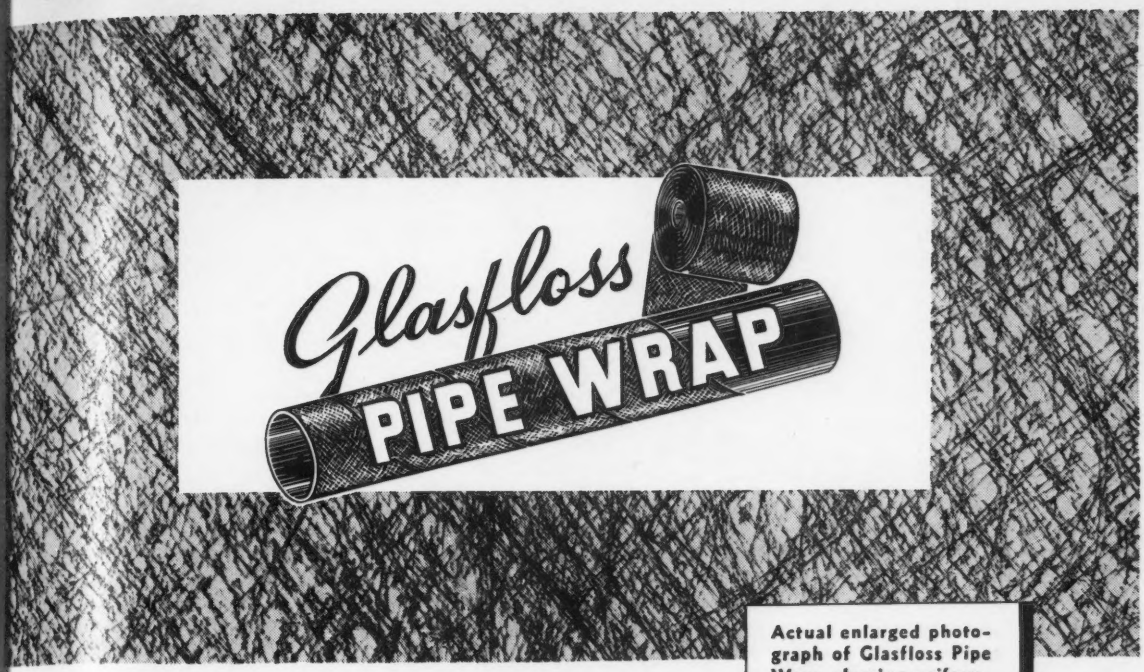
Integrated Core . . . an electro-galvanized, full-length, spiral-wound strip core perfectly bonded to the magnesium alloy . . . assures continuing operation.

Silver-Soldered Lead Wire Connections for lasting, non-corrosive connections with low resistance.

Shape and Weight To Your Specifications . . . for maximum efficiency. Stock sizes also: 5" sq., 4" sq., and 3" sq., in lengths from 15" to 66".

Federated also supplies PACKAGED ANODES of standard 17 lb. and 32 lb. size with backfill to your specification . . . for easy field installation.

Federated Metals Division
AMERICAN SMELTING AND REFINING COMPANY • 120 Broadway, New York 5, N.Y.



Actual enlarged photograph of Glasfloss Pipe Wrap, showing uniformity and continuity of glass fibers.

The underground pipe wrap with the triple punch

TENSILE STRENGTH

Continuous glass fibers running full width of mat.

POROSITY

Long glass fibers arranged in a pattern that gives maximum porosity.

BINDER

Coal tar derivative.

Available for immediate shipment...

from our Tulsa warehouse or from factory at Hicksville, N. Y., in 400 foot rolls in widths 3", 4", 6", 9", 12", 18", and in 800 foot rolls in widths 9", 12", and 18".

Distributed Exclusively by

PERRAULT Brothers

TELEPHONE 5-1103 • 1130 NORTH BOSTON • TULSA 6, OKLA.

EXPORT OFFICE, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y. PHONE CIRCLE 6-6260

Weather Deck Coating System For Ships and Drydocks Sought

By ALVIN C. GOETZ*

THE BUREAU OF SHIPS and the Bureau of Yards and Docks are developing a coating system for use on steel weather docks of vessels and pontoon decks. Their objective is a system which will eliminate the necessity of having a portion of ship's force constantly engaged in touching up these areas.

To assist them in this project, the bureaus have requested the "National Security Industrial Association Paints and Related Protective Coatings Advisory Committee" to collect relevant technical data on systems already developed by industry which may meet their specifications. NACE is assisting the NSIA and the bureau by making requests of all interested members to submit relevant technical and other data to the bureaus through the NSIA committee.

The specific objective is to develop a satisfactory paint coating system for use on steel weather decks of Naval vessels and on steel pontoon decks of Naval floating drydocks including a suitable specification for the procurement of the system from commercial sources.

* Eagle-Picher Co., American Building, Cincinnati, Ohio.

Present Coating System

The present Navy standard paint coating system for steel weather decks is:

Two coats of zinc chromate primer, Specification JAN-P-735 (formerly Specification 52P18) or, alternately, two coats of red lead primer, Formula No. 116, followed by two coats of gray deck paint, Specification JAN-P-699 (formerly Specification 52P42).

This is essentially a long oil alkyd resin base coating system with some admixture of phenolic resin base varnish in the gray deck paint. The present coating system for steel pontoon decks is two coats of coal tar pitch emulsion, specification 52C47. Other systems have been tried on drydocks including the weather deck system noted above, but the results have been disappointing.

The service environment on weather and pontoon decks is basically the same. The paint system will be applied to horizontal steel surfaces and exposed to prevalent and all possible variable weather conditions associated with ships at sea and seacoasts. In addition the systems are subjected to heavy foot traffic and to bumping and dragging of gear. In the case of Naval oil tankers when loaded and floating drydocks in operation the weather and pontoon decks are frequently awash. It is impractical to set deck areas aside for prolonged periods in order to accomplish painting. Coating systems must be rapid drying. A desirable but not essential property to be achieved in the coating system is the factor of non-skidding.

The Problem

Presently used deck paint systems do not afford adequate protection. Pin point and general corrosion is noticeable often within a few weeks after application of presently used paint systems on many vessels especially gasoline and oil tankers and

(Continued on Page 18)

CORROSION PREVENTION with typical Chromate Applications

DRILLING — Introduce sufficient Sodium Bichromate into the drilling mud to maintain a concentration of 2000 to 3000 ppm in the water.

GAS CONDENSATE WELLS — Inject continuously into the annulus between the tubing and casing a Sodium Bichromate solution at a constant rate to maintain 50 to 100 ppm in the water which separates at the well head.

GASOLINE PIPE LINES — Inject Sodium Chromate solution into the suction side of the station pump at a rate to maintain a positive test for hexavalent chromium at the discharge end of the pipe line; or at the next pump station where chromate solution is injected, usually 50 to 200 miles.

Write for complete information about the applications in which you are interested.

SODIUM CHROMATE • SODIUM BICHROMATE
POTASSIUM CHROMATE • POTASSIUM BICHROMATE

MUTUAL CHEMICAL CO. OF AMERICA
SINCE 1845
270 Madison Avenue, New York 16, N. Y.

NACE MEMBERS

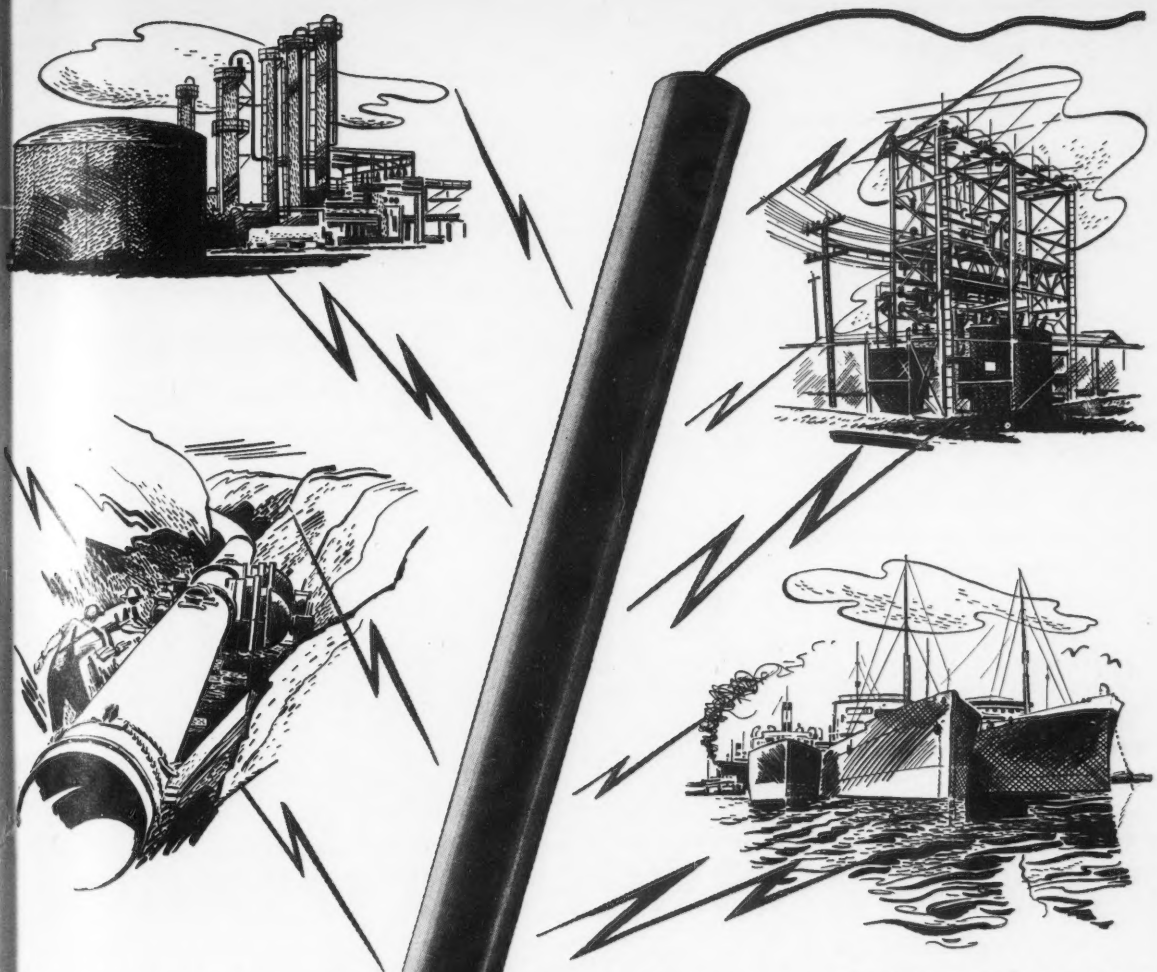
IF You Change Addresses

IF You Change Company Affiliation

IF You Change Positions

Please notify the Central Office NACE, 919 Milam Building, Houston 2, Texas, so that you will get CORROSION without delay and that association records can be kept abreast of your progress.

THANKS!



PROTECT METAL STRUCTURES POSITIVELY UNDER ALL CONDITIONS!

"NATIONAL" GROUND ANODES

● Regardless of what the job is . . . how corrosive the environment—whether wet or dry, hot or cold—you can depend upon "National" ground anodes to provide efficient, positive protection against underground and underwater corrosion.

"National" ground anodes have proved themselves in 20 years of successful operation in many different parts of the country. They outlast other materials by a wide margin. They do not have to be dug up and replaced every couple of years. Because they use a controllable current source, it is simple and economical to adjust their protective output to match exactly the requirements of any installation.

For complete details on "National" ground anodes, write to National Carbon Division, Union Carbide and Carbon Corporation, Dept. Z.

The terms "National" and "Eveready" are registered trade-marks of

NATIONAL CARBON DIVISION
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
Foreign Department: U. S. A.

MORE THAN DOUBLE THE USABLE LIGHT!

The biggest news since the invention of flashlights—the brand new leakproof "Eveready" No. 1050 flashlight battery—gives more than double the usable brilliant white light for critical uses than any other flashlight battery we ever made.

NO METAL CAN TO LEAK OR CORRODE

PAINTING MAINTENANCE FOR INDUSTRY

Specializing in the Utility and Industrial Fields

SERVING THE NORTHEAST REGION

Devoted to the proper preparation of surfaces and the application of anti-corrosive material.

Inquiries Invited

WILLIAM G. PITTMAN

219 SUSSEX ST., HACKENSACK, N. J.

HAckensack 3-5185

N.A.C.E. Member

Weather Deck—

(Continued from Page 16)

on pontoons of operating floating drydocks.

Formulations based on vinyl and vinyl-alkyd resins and others based on chlorinated rubber, chlorinated paraffin and phenolic resin varnishes have been tested on one U.S. Naval Tanker. After eight months service, a system based on a metal conditioner (vinyl wash coat), vinyl resin primer and vinyl alkyd topcoat was found to be in good condition. The wash coat primer was found to help the standard system.

The Desired Data

The bureaus are, at this time, interested primarily in obtaining information on the present status of industrial developments in this field. After a survey has been made by the bureaus, samples will be requested of those coatings which appear promising. Those interested should submit data or inquiries to:

Mr. Patterson Humphrey
National Security Industrial Assn.
110 William Street
New York 7, New York

•

A 500-milligram capsule of radium was placed in a "Go-Devil" used to clean Southern California Gas Company's Goleta pipe line so that the radiations would register the location of the cleaner if it stuck in the line, *The Petroleum Engineer* reported in its May, 1950, issue.

Lead Hygiene Conference Proceedings Are Issued

Proceedings of the Lead Hygiene Conference held in Chicago in November 1948, are now available from the Lead Industries Association, 420 Lexington Ave., New York 17, N. Y., at $1 per copy. The 137-page book has 33 illustrations and contains articles related to the prevention, control and treatment of lead poisoning and related industrial hazards.

Prizes Are Awarded In Steel Contest

Prize winners in the Cooper Alloy Foundry Company's contest concerning "Applications for Cast Stainless Steel in the Chemical Industry" have been announced as follows:

First prize, Howard J. Sanders, chemical engineer with Calco Chemical Division, American Cyanamid Co.

Second prize, John D. Altstetter, metallurgical engineering student, Ohio State University.

Third prize, Max J. Sorensen, student, Villanova College.

•

A list of addresses of new members and changes of addresses of old members will be a monthly feature of CORROSION magazine.

1951 CONFERENCE AND EXHIBITION

excellent technical program
11 symposia • 38 papers

march in new york

greatest exhibition • over 100 booths

HOTEL STATLER • MARCH 13 • 14 • 15 • 16

THE PREFERRED METAL FOR CATHODIC PROTECTION IN LOW RESISTIVITY MEDIA

HORSE HEAD SPECIAL ROLLED ZINC PLATES

99.99+% PURE ZINC

THE NEW JERSEY ZINC COMPANY

Products distributed by

The New Jersey Zinc Sales Company

160 FRONT ST., NEW YORK 7, N. Y. • 221 NO. LA SALLE ST., CHICAGO 1, ILL.

Revised Corrosion Abstract Index Put Into Effect

Effective with this (July, 1950) issue of Corrosion abstracts published in the Corrosion Abstracts Section will be classified under the revised abstract index issued June 12, 1950, by the National Association of Corrosion Engineers' abstract committee of which Miss Marguerite Bebbington, International Nickel Co., Inc., New York, is chairman. Although the revisions affect main classifications 1. General, 2. Testing, 4. Environments, 6. Materials of Construction, 7. Equipment, the indexing of abstracts in the first six issues of volume six, (January-June, 1950 inclusive) will not be affected in every second position division by changes under these headings.

The revision presented here should be used for reference to issues for the last six months (July-December, 1950 inclusive). Where changes have been made, the changed subdivisions *only* have been set in italic type. This will make it possible for those who wish to do so to re-classify under the new index, all abstracts classified under the old index in the first six issues of the volume.

NACE ABSTRACT FILING SYSTEM

June 12, 1950, Revision

(Headings here apply to main and first sub-headings in long form.)

1. GENERAL
   1. Miscellaneous
   2. Importance
   3. Reviews
   4. Bibliographies
   5. *Directories Including Materials*
   6. Books
   7. Organized Studies of Corrosion
   8. Fundamentals
   9. *Personalities*
2. TESTING
   1. General
   2. On Location Tests
   3. Laboratory Tests
   4. Instrumentation
   5. Standardization & Specifications
   6. *Specimen Treatment*
   7. *Evaluation*
3. CORROSION TYPES & INFLUENCING FACTORS
   1. General
   2. Types
   3. Factors Biological
   4. Factors Chemical
   5. Factors Physical & Mechanical
   6. Factors Electrochemical
   7. Factors Metallurgical
4. ENVIRONMENTS
   1. General
   2. Atmospheric
   3. Chemicals Inorganic
   4. Chemicals Organic
   5. Soil
   6. *Water and Steam*
   7. Molten Metals
5. PREVENTIVE MEASURES
   1. General
   2. Cathodic Protection
   3. Metallic Coatings
   4. Non-Metallic Coatings
   5. Oil & Grease Coatings
   6. Packaging
   7. Treatment of the Medium
   8. *Inhibitors (Passivators)*
   9. Surface Treatment
   10. Miscellaneous Methods
6. MATERIALS OF CONSTRUCTION
   1. *General*
   2. *Ferrous Metals*
   3. *Non-Ferrous Metals, Heavy*
   4. *Non-Ferrous Metals, Light*
   5. *Non-Metallic*
   6. *Duplex Materials*
   7. *Metals Multiple*
7. EQUIPMENT
   1. *Engines and Turbines*
   2. Valves and Pipes
   3. Pumps and Compressors
   4. Coils and Heat Exchangers
   5. Containers
   6. Structural Shapes
   7. *Electrical and Telephone*
   8. *Wires and Cables (Non-electrical)*
   9. *Specifications*
   10. *Miscellaneous*
8. INDUSTRIES
   1. Group I
      1. Air Conditioning
      2. Refrigeration
      3. Sewage and Water
      4. Architecture
   2. Group II
      1. Communications
      2. Power
   3. Group III
      1. Agriculture
      2. Food
      3. Fermentation
   4. Group IV
      1. Fuel
      2. Gases
      3. Petroleum Refining and Production
      4. Rubber
   5. Group V
      1. Ceramics
      2. Glass
      3. Wood Products
      4. Pulp and Paper
   6. Group VI
      1. Textiles
      2. Laundry
   7. Group VII
      1. Instruments
      2. Jewelry
      3. Photography
      4. Printing & Lithography
   8. Group VIII
      1. Chemical Manufacturing
      2. Leather & Tanning
      3. Electroplating

   Group IX
      1. Aircraft
      2. Automotive
      3. Marine
      4. Railroad
      5. Pipeline
   10. Group X
      1. Metallurgy
      2. Mining
      3. Ordnance & War Materials

FAHRITE
Stainless Steel CASTINGS
HEAT AND CORROSION RESISTANT ALLOYS
CARBON AND OTHER ALLOY STEEL CASTINGS
An outstanding engineering and metallurgical staff is ready to help you design dependable castings that fit your needs exactly . . . and economically.
THE OHIO STEEL FOUNDRY COMPANY
SPRINGFIELD, OHIO
Plants at Springfield and Lima, Ohio

ASM New Officers And Trustees Named

New officers and trustees for 1950-5 have been named as follows by the American Society for Metals:

Walter E. Jominy, staff engineer, Chrysler Corp., president; Dr. John Chipman, Head of Department of Metallurgy, Massachusetts Institute of Technology, vice-president; W. H. Eisenman, renominated secretary; Ralph E. Wilson, Chief Metallurgist, Timken Steel and Tube Company, Canton, O., treasurer. New trustees include J. B. Austin, Director of Research Laboratories, U. S. Steel Corp., Kearney, N. J.; Dr. James T. MacKenzie, Chief Metallurgist, American Cast Iron Pipe Company, Birmingham, Ala.

The THREDKOTES are a group of compounds developed especially for various types of threaded connections used in the petroleum industry and *field-tested to give your threads longer life.*

On highly-machined threads, THREDKOTE prevents galling, acts as a lubricant. On loose or worn threads, there's a THREDKOTE that seals the joints, works well under pressure and load.

Wherever you use threaded pipe, also use a Humble THREDKOTE to save the threads and seal the joints.

THREDKOTE

is sold by

HUMBLE OIL & REFINING COMPANY, Houston, Texas

THE CARTER OIL COMPANY, Tulsa, Oklahoma

and leading oil field supply houses everywhere.

THREDKOTE 701	THREDKOTE 702	THREDKOTE 705	THREDKOTE 708
For extreme pressure connections, oil well casing and tubing, tool joints.	For Christmas Tree assemblies, steam lines.	For extreme and high pressure connections.	For air lines, bolted tanks, gas and gasoline lines, gasket seals, oil well casing and tubing, permanent sealer.

NEW PRODUCTS—Materials—Service—Literature

Apex Smelting Company has issued a letterfile-size folder giving details of its magnesium anodes for cathodic protection. Simplified descriptions of corrosion processes and diagrams showing typical anode installations are included. Middle West Coating & Supply, 807 Daniel Bldg., Tulsa, Okla., is middle west representative.

•

Relative Humidities can be determined quickly through use of a pocket instrument developed by Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. The instrument uses the wet and dry bulb method with a psychometric slide rule forming part of the case.

•

Asphaltic "Binderseal," which may be sprayed on above-grade surfaces and then finished with a coating of granules for decorative effect, is recommended by The Flintkote Company, Industrial Products Division, 30 Rockefeller Plaza, New York 20, N. Y., as a coating for surfaces where asphalt formerly was not used for esthetic reasons. The decorative granules are supplied in several sizes and colors and are said to be light fast and treated to prevent dusting and damage from abrasion. Those interested should ask for Series I-C, Number 227, Issue A-50 data sheet, which gives full explanation of the materials.

•

Pipe Joint coverings that the manufacturers, Dresser Manufacturing Division, Bradford, Pa., say can be installed in one-tenth of the time normally needed to coat a pipe joint are now available in special shapes to cover and protect Dresser-coupled joints, welded joints and insulating joints. The "Zipcoats," which are closed with a strip-type fastener, are said to give protection equal or exceeding that of mill or yard-wrapped pipe. They also have high dielectric strength and contain an anaerobic microbiological corrosion inhibitor.

•

Transmission and Distribution pipe lines can be protected against corrosion through the use of common sense and proved methods. This is the principal theme of a booklet, "Dollars and Sense of Cathodic Protection for Transmission and Distribution Pipe Lines," published by Electro Rust-Proofing Corp. (N.J.), Belleville 9, N.J. The booklet includes cathodic protection case histories, a discussion of the requirements for a successful cathodic protection installation and a statement of the services offered by the firm. Copies may be obtained on request.

•

An Automatic Valve which serves to vent accumulated moisture or oil from air-brake systems, air lines and compressors is being marketed by Master Equipment Sales, 15 N. Broadway, Dayton, Ohio.

•

Flashlight Batteries that have an inert carbon lining that will not corrode and permit leakage of electrolyte as in other batteries which have the corroding zinc case on the outside are being manufactured by the National Carbon Division, Union Carbide and Carbon Corp. The zinc element of the cell consists of vanes suspended in the interior of the cylinder and in the electrolyte. The manufacturers claim the new cell gives more light-minutes than any previous cell, providing more than double the usable light. The cell is called "Eveready No. 1050."

•

Micro-Seal No. 3 and 3A coatings, chemically dispersed asphalt emulsions containing no water and no naptha or volatile hydrocarbons are being offered as corrosion-resistant materials for exterior application through Farley Co., Inc., 526 M & M Building, Houston 2, Texas. Manufactured by Anderson-Prichard Oil Corp., Oklahoma City, Okla., the emulsion is a proprietary compound consisting of asphalt, short or medium fibered asbestos and inert mineral fillers. Claims for the material in-

Kick Corrosion Off Your Payroll . . .
with GAMA Asbestos Pipe Line Felt

A strong asbestos felt made of quality materials to meet the exacting requirements of pipe line service.

Because Gama Felt is made of high purity asbestos, it provides the best possible protection for long pipe line life.

"the felt with a future"

GAMA ASBESTOS PIPE LINE FELT IS DESIGNED:

- To prevent soil stress on coatings.
- To prevent backfill damage.
- To pull coatings tightly to the pipe.
- To give even thickness of enamel on bottom, sides, and top of pipe.
- To be a protection for the coatings beneath it.

DISTRIBUTED BY:

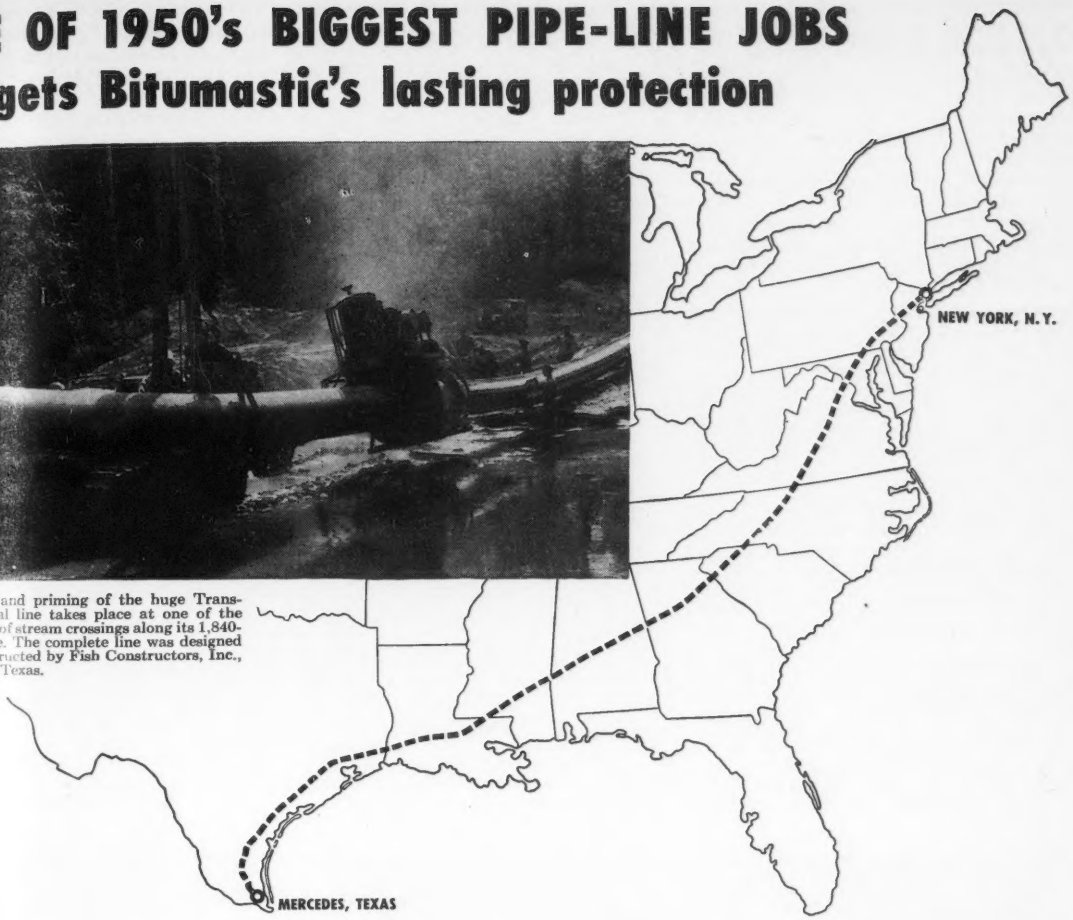
MIDDLE WEST COATING & SUPPLY

Write for Literature and Prices

207-A Daniel Bldg. TULSA, OKLA. Telephone 2-0865

ONE OF 1950's BIGGEST PIPE-LINE JOBS gets Bitumastic's lasting protection

Cleaning and priming of the huge Transcontinental line takes place at one of the hundreds of stream crossings along its 1,840-mile route. The complete line was designed and constructed by Fish Constructors, Inc., Houston, Texas.



●By late Fall, the 1,840-mile line being laid by the Transcontinental Gas Pipe Line Corporation will be supplying natural gas to the Philadelphia—New York—New Jersey area.

And, like many of the country's other big pipe-line projects, it will be protected against corrosion by Koppers Bitumastic® Enamel for many miles of its length. Portions of the 30-inch line which Bitumastic will protect include some of the most highly corrosive soils encountered—low, swampy land along the Gulf Coast.

Bitumastic Enamel has been used for over 25 years in coating thousands of miles of gas and oil lines. The knowledge gained by Koppers from the experience on these many successful applications can prove to be of value on your next pipe-line job.

Put "Koppers Bitumastic Enamel" into the specifications of your next job. You'll be getting a coating that has proved itself by years of satisfactory service under the most extreme corrosive conditions . . . in all types of soil . . . under variations of temperature.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS BITUMASTIC ENAMELS
REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 704T, Pittsburgh 19, Pa.

clude: Deposition by spray-gun at 30 to 50 psi at temperatures from 40 degrees F to over 100 degrees F. A gallon will coat 25 sq. ft. 1/16-inch thick. Thicker layers, up to 3/32-inch for No. 3 and to any desired thickness for No. 3A, without sagging are claimed. Overspray mist dries in 3 to 5 feet and can be brushed off. Shilstone Laboratories assign no flash point up to 600 degrees F, and gives 728.6 F as ignition temperature. ICC classifies it as not flammable.

The material is non-toxic, completely odorless when cured, does not gray in weather, cures from the under surface out, developing "body" in the mass with a curing time of about three hours. No sign of attack of metal covered was found after immersion in 10 percent hydrochloric acid, sulfuric acid or caustic soda. A 450-hour 5 percent fog test produced no blistering or lifting, and metal covered was uncorroded, manufacturers say.

Materials in the emulsion are non-corrosive, will not freeze above 0 degrees F, and will return to original state after freezing. Excellent abrasion resistance, pliability and resistance to flow at elevated temperatures is claimed also.

•

"Materials for Bromine Containers" by George S. Haines, Westvaco Chemical Division, Food Machinery and Chemical Corp. a reprint from Dec. 1949 *Industrial and Engineering Chemistry* is available from the International Nickel Co., Inc., 67 Wall Street, New York, N.Y. The report includes studies of materials and data on methods as well as results obtained.

•

Impervious Graphite, "Karbate," with Neoprene gaskets, is the material used in National Carbon Division, Union Carbide and Carbon Corp., 30 East 42nd St., New York 17, N.Y., circulating steam jets. Catalog Section M-9101, available on request, gives full data on the jets.

•

"Stop Corrosion With Metallizing," is the title of an 8-page descriptive circular showing many applications of metallizing to inhibit corrosion. Copies of the Bulletin, No. 62, may be obtained from Metallizing Engineering Company, Inc., 38-14 30th Street, Long Island City 1, N.Y.

•

"Nickelsworth" a publication of The International Nickel Co., Inc., 67 Wall Street, N.Y. City is for suppliers of nickel alloys. Stories and illustrations give specific instances of the uses of nickel alloys for corrosive services.

•

A. M. Byers Company expects to be producing wrought iron sheet from 8 to 22 gauge, black and galvanized, about June 1.

•

Carboline Company, 7603 Forsyth Blvd., St. Louis 5, Mo., has issued a technical data sheet listing uses of the company's products for repair of rubber lined equipment, glass lined equipment, wood tanks, steel tanks, wood floors and concrete floors. Corrosion resistance to acids, alkalis, except nitric, chromic and sulfuric above 45 per cent and resistance to most solvents, is claimed. Temperature limit is 350 degrees. Further information on the company's products is offered.

•

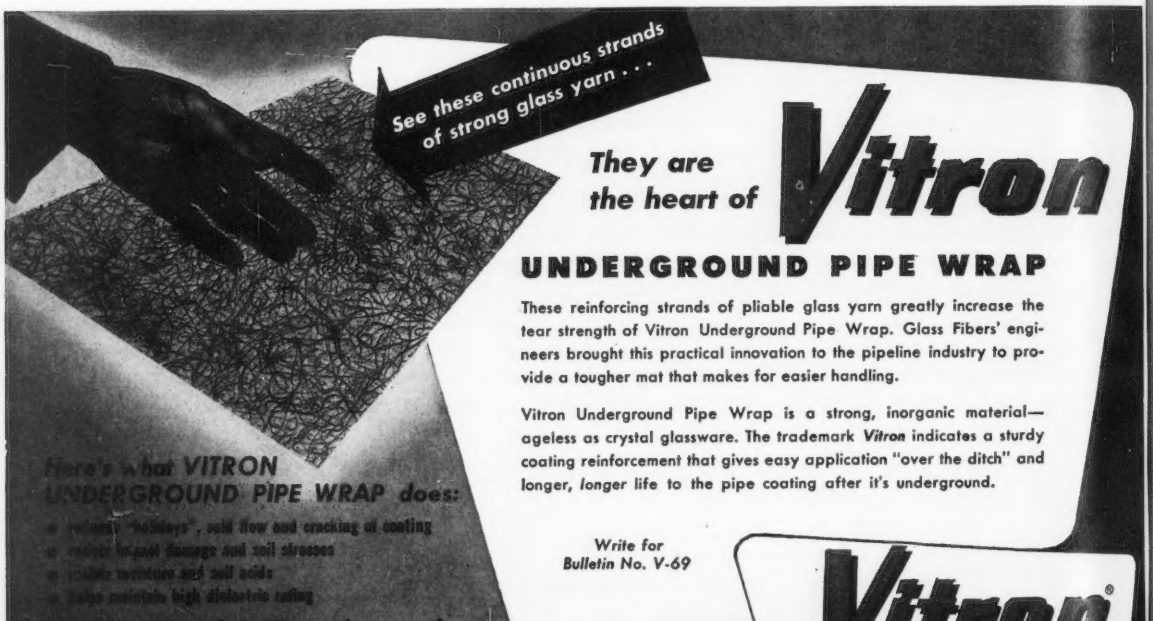
R. Hoe & Co., New York, has installed a metal lithographing and roller-coating press to print colors on 50x72-inch sheets of 16-gauge steel. The press can roller-coat with corrosion-resistant lacquers both the inside of the sheets and the heads for fabrication of 55-gallon drums.

•

Sil-Var, a duplex coating consisting of aluminum and mineral asphalt or black bitumen is recommended by the manufacturers, Service Industries, 2100 E. Somerset St., Philadelphia 34, Pa., for use as a coating on exterior surfaces where its high adhesion and the reflective value of aluminum are useful. Further information may be obtained from the manufacturers.

•

CORROSION magazine seeks for publication notices of meetings of associations other than NACE which conduct corrosion investigations and research work. Members who know of such activities not reported in CORROSION are asked to notify Central Office so steps may be taken to publish the information.


See these continuous strands of strong glass yarn . . .
They are the heart of Vitron
UNDERGROUND PIPE WRAP
These reinforcing strands of pliable glass yarn greatly increase the tear strength of Vitron Underground Pipe Wrap. Glass Fibers' engineers brought this practical innovation to the pipeline industry to provide a tougher mat that makes for easier handling.
Vitron Underground Pipe Wrap is a strong, inorganic material—ageless as crystal glassware. The trademark Vitron indicates a sturdy coating reinforcement that gives easy application "over the ditch" and longer, longer life to the pipe coating after it's underground.
Write for Bulletin No. V-69
Vitron
GLASS FIBER
UNDERGROUND PIPE WRAP
GLASS FIBERS INC.
WATERVILLE, OHIO

PERSONALS

A. E. Pecore, Houston, has been promoted to general superintendent of Humble Pipe Line Company.

•

Albert S. Munneke, corrosion engineer with Stanolind Pipe Line Company has been transferred to Shawnee, Okla., as Oklahoma area engineer.

•

Leonard P. Schaefer has been named a corrosion engineer with Hinchman Corporation, Francis Palms Bldg., Detroit, Mich. The firm does location and leak surveys for underground plant, provides corrosion mitigation engineering technical services and control materials and instruments.

•

Capt. Alfred F. Olivet, USNR, and **John P. Ahrens** have been named directors of American Cladmetals Co., Carnegie, Pa.

•

Richard Rimbach, publisher of "Instruments," left March 28 for a tour of England, France, Germany, Belgium and Switzerland.

•

Gessner G. Hawley, formerly chief technical editor for The Reihold Publishing Co., 330 West 42nd St., New York, has been made editor-in-chief and production manager of the firm.

•

D. Earl McElroy has been named Los Angeles, Cal., district office salesmanager by Lukens Steel Co., Coatesville, Pa.

•

Dr. William G. Theisinger has been named regional salesmanager for Lukens Steel Company, with headquarters at Houston, Texas. He will supervise activities in 12 Southern states from South Carolina to California.

•

Bernard E. David, and **Walter Gordon List** have been named special field engineers for the Los Angeles, Cal. and Pittsburgh, Pa. territories and **J. J. Schlass,** will be sales representative in the Philadelphia district for Arcos Corporation, 1500 South 50th St., Philadelphia 53, Pa.

•

Gordon S. Schuhmacher has been named district manager in Los Angeles for Hagan Corporation, Pittsburgh combustion and chemical engineering firm and its subsidiaries, Calgon, Inc., Hall Laboratories, Inc. and the Buromin Co. He will be assisted by **Joseph R. Shafer.**

•

Frank L. Blodgett has been named salesmanager for Alloy Rods Company hard surfacing division with headquarters at York, Pa., main office of the firm. The firm manufactures hard facing and tool steel electrodes.

•

Dearborn Chemical Company announces addition of 12 representatives to its sales and service staff. They are **T. Armstrong,** West Texas and New Mexico; **R. W. Bartlett,** New England; **C. P. Blakely,** New Jersey; **T. Bull,** Northern California; **J. W. Fisher,** Eastern Ohio; **R. E. Johnson,** northern part of Chicago; **W. J. Mercier,** Southern Wisconsin; **R. T. Moran,** part of Michigan; **D. E. Pedginse,** Northern Indiana and **H. O. Scott** Central Ohio. **V. P. Nobile** will assist **E. M. Welch,** manager of Dearborn's industrial water treatment department and **K. W. Franks** will assist **J. F. Wilkes,** technical director of Dearborn's railroad department both at the technical department in the Chicago office.

•

C. S. Beard has joined Ebasco Services as gas engineer.

•

Joseph H. Harris has been named salesmanager of the North Chicago, Ill. branch of Atlas Powder Company's industrial finishes department. **Benedict H. Meyer** has been named representative for Zapon finishes in Iowa, Nebraska, Kansas and Western Missouri.

•

J. P. Murphy has been transferred from Dow Chemical Company's magnesium technical service and development group to the magnesium sales staff at Chicago, Ill.

•

Charles E. Kaufman has been named director of research for Hall Laboratories, Inc., Pittsburgh, Pa.

•

A. S. Johnson has been named general manager of National Carbon Division of Union Carbide and Carbon Corp.

•

Fred Ohrt was elected March 21 as a delegate to the Hawaii constitutional convention, which began work April 4 in anticipation of approval by the Congress of statehood for the territory.

•

Carl E. Schmitz, vice-president and director of engineering of Crane Packing Company, Chicago, has been elected vice-president-at-large of the American Society of Lubrication Engineers.

•

Grover Seaberg, formerly with Peoples Gas Light & Coke Co. of Chicago, Dresser Coupling Co., Pittsburgh Equitable Meter Co. and Walworth Company, who for several years operated a foundry in California, has been named West Coast representative of Middle West Coating and Supply, Tulsa, Okla.

•

Dr. Everett P. Partridge, director of research of Hall Laboratories, Inc., and Calgon, Inc., has been named director of Hall Laboratories, Inc.

•

Dowell Incorporated recent promotions have been announced as follows: **W. N. "Woody" Estel,** Midland district manager, named sales development manager with headquarters at Tulsa; **Ralph H. Smith,** Houston district manager, will take charge of West Texas activities from Midland; **John S. "Jack" Talbot,** Houston district sales engineer, has been named Houston sales manager; **E. F. Kelly** has been named district engineer at Houston.

•

L. J. Amsdell has been appointed director of the Pipe Joint Division of Gates Engineering Co., New Castle, Del.

•

The Managing Editor of CORROSION magazine always is happy to see photographs considered suitable as subjects for the covers of the magazine. Address such photographs together with descriptive captions and release for use to the Central Office.

for unusual resistance to tidewater conditions

Micro-Seal

CHEMICALLY - DISPERSED ASPHALT MASTICS SUPERIOR FOR

10 REASONS

1. Cures from applied surface out, emitting vapors present even after sandblasting or thorough cleaning.
2. Remains pliable after curing. Protects against corrosion and keeps insulating properties.
3. Can be sprayed easily. Special anti-sag characteristics.
4. Better coverage because of minimum shrinkage.
5. No heating or thinning with inflammables. Rated non-flammable by U. S. and Underwriters' Laboratory Standards.
6. Cures faster throughout coating than any competitive material tested.
7. No toxic hydrocarbon vapors—odorless when cured.
8. Less thermal conductivity than competitive materials tested.
9. Resists abrasion better than competitive materials tested.
10. Permanently resistant to acid, alkali and salt spray after proper curing.

• Let us tell you about successful applications on Gulf Coast chemical and petro-chemical installations where humidity, salt and corrosive industrial atmospheres put any coating to a real test!

• Micro-Seal Products are made by one of America's best-known asphalt producers. Test and performance data available on request. No obligation. Write or telephone.

FARLEY

COMPANY, INC.

Phone FAirfax 1000

M & M BLDG. HOUSTON, TEX.

CORROSION LITERATURE

Available From

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

BIBLIOGRAPHIC SURVEY OF CORROSION, 1945

Single copy postpaid to members of the Association $4.00
To non members of the Association 5.00

JOINT SYMPOSIUM ON CATHODIC PROTECTION

To members of the Electrochemical Society and National Association of Corrosion Engineers, per copy 6.00
To all others, per copy 8.00

PROCEEDINGS, FIRST ANNUAL MEETING, NACE

Single copy postpaid to members of the Association 3.00
To non members of the Association 6.00

DIRECTORY, AMERICAN COORDINATING COMMITTEE ON CORROSION

Single copy, postpaid 2.00

FIRST INTERIM REPORT ON GROUND ANODE TESTS of Technical Practices Committee No. 3 "Anodes for Impressed Currents"

Single copy postpaid to members of the Association 3.00
To non-members of the Association 5.00

CONTROL OF PIPE LINE CORROSION

by O. C. Mudd

Single copy, postpaid $1.25
(Five or more copies to one address, postpaid at $1.00 per copy)

SELECTED BIBLIOGRAPHY ON SALT SPRAY TESTING

by Lorraine R. Voigt

Single copy, postpaid ..... $ .50

THE MITIGATION OF CORROSION ON CITY GAS DISTRIBUTION SYSTEMS

by A. D. Simpson, Jr.

Single copy, postpaid ..... $ .50

CAUSES OF CORROSION IN AIRPLANES AND METHODS OF PREVENTION

N. H. Simpson

Single copy, postpaid ..... $ .50

THE USE OF AMMONIA IN CONTROL OF VAPOR ZONE CORROSION OF STORAGE TANKS

by F. T. Gardner, A. T. Clothier and F. Coryell

Single copy, postpaid ..... $ .50

CORROSION Magazine

Most back issues are still available
Single copies to members, postpaid ..... $ .50
Single copies to non-members, postpaid ..... $ .75

TO: NATIONAL ASSOCIATION OF CORROSION ENGINEERS, 919 Milam Bldg., Houston 2, Texas

Please send me the following publications:

Quantity

( ) Bibliographic Survey of Corrosion
( ) Joint Symposium on Cathodic Protection
( ) Proceedings, First Annual Meeting
( ) Directory, American Coordinating Committee on Corrosion
( ) First Interim Report On Ground Anode Tests
( ) Control of Pipe Line Corrosion
( ) Selected Bibliography on Salt Spray Testing
( ) The Mitigation of Corrosion on City Gas Distribution Systems
( ) Causes of Corrosion in Airplanes and Methods of Prevention
( ) The Use of Ammonia in Control of Vapor Zone Corrosion of Storage Tanks
( ) CORROSION Magazine [Indicate month ( ) and year ( )]

Name .....

Street .....

City ..... Zone ..... State .....

I am (not) a member of NACE.
Check one: I wish to be billed for these publications at . $.....

I am enclosing a check for $.....

Corrosion Abstracts

Index to CORROSION ABSTRACTS

	Page
1. GENERAL	
1. Miscellaneous	27
7. Organized Studies	27
8. Fundamentals	27
5. PREVENTIVE MEASURES	
9. Surface Treatment	28
7. EQUIPMENT	
4. Coils and Heat Exchangers	32
5. Containers	34
8. Wires and Cables	34
8. INDUSTRIES	
2. Group II	35
3. Group III	35
4. Group IV	36
9. Group IX	38

Abstract Section Style Outlined

For ease in locating reference data, CORROSION uses a uniform style in its Abstract Section.

The abstracts first are broken down into major classifications of the more common types of corrosion literature. In each review the title of the article is presented in bold face type, followed by the author's name. The publication from which the article was abstracted is printed in italics and is abbreviated in most instances. Following this, in sequence, are the volume (bold face), number in the volume, pages, year and month of publication. In some instances a second reference will be listed in the same manner. This indicates that the article also was published or abstracted in another publication. A brief summary of the article follows the above information and it is concluded with an abbreviation indicating the source of the abstract and contributor. The meanings of these abbreviations usually are listed on the first page of the Abstract Section.

When seeking more detailed data about an abstract, best source of information is the publication in which the article appeared originally. (Listed in italics in the heading.) The contributor of the abstract also may be able to supply additional information. Addresses of most of these publications may be found in the reference section of most public libraries.

GENERAL

• Miscellaneous

1.1, 1.7

Britain's Combat With Corrosion. Wilfred F. Coxon. *Metal Prog.* **56,** 79-80 (1949) July.

Outlines work of corrosion section of Britain's Chemical Research Laboratory on a variety of corrosion problems during the war.

1.1

Punch Card for the Field of Metal Finishing. T. A. Hood. *Metal Prog.,* **56,** 75-78 (1949) July.

Describes and illustrates the above, designed at the Defence Research Laboratories of the Commonwealth of Australia's Department of Supply and Development. It is the first of a coordinated series of cards planned to cover each of several divisions of metallurgy. —BLR.

1.1

What Causes Corrosion of Metals? W. H. Lang. *Heating & Vent.,* **45,** 64-66 (1948) Nov.—BL.

• Directories Incl. Materials

1.5, 6.7, 7.10

Corrosion Guide for Fasteners. H. M. Harper Co. *Product Eng.,* **20,** No. 7, 161 (1949) July.

Reference book sheet giving corrosion resistance ratings for brass and naval bronze, silicon bronze, Monel, stainless steel (8 types), and copper, in contact with 100 different chemicals. The ratings are applicable only if the metals are used as screws, bolts, etc.—BNF.

• Organized Studies

1.7, 2.2, 2.3, 4.6

Summary of Discussions at Informal Conferences on a Critical Appraisal of Testing Methods, Kure Beach, North Carolina. F. L. LaQue. *Prev. Det. Abs.,* 5, M 98 (1948).

Factors affecting reliability of marine tests of corrosion and marine organism attack and of protective coatings and preservatives are discussed. Preparation of and number of specimens, length of exposure, number of test locations, merits and limitations of laboratory tests and details of exposure and inspection methods are among the factors considered.—RPI.

1.7

Corrosion Testing Basin Yields Data of Value to Maritime Field. F. L. LaQue. *The Amer. Marine Eng.,* **41,** No. 6, 9 (1948) June.

Description of Kure Beach testing station.—INCO.

1.7, 5.10, 2.2

Marine Corrosion Findings at Kure Beach Reviewed. *Chem. Eng. News,* **27,** No. 26, 1867 (1949).

Large scale adoption of magnesium sacrificial anodes for metal underwater dock facilities, complete absence of corrosion attack in tests to date on titanium metal and the discovery that complete immersion of steel test strips greatly reduces corrosion as compared to test strips not in continuous contact with water, are some of the highlights of recent corrosion testing at Kure Beach. Coal-tar enamels, chlorinated rubber and vinyl-based paints perform well in the destructive marine atmosphere. Stainless steel, aluminum and nickel powders have been used as pigments in vinyl resin based paints.—RPI.

• Fundamentals

1.8, 6.3

The Oxidation of Copper and the Reactions of Hydrogen and Carbon Monoxide with Copper Oxide. W. E. Garner, T. J. Gray and F. S. Stone. *Proc. of the Royal Soc.,* ser. A, **197,** 294-314 (1949) June 22.

Reviews investigation made of the activation of copper. Heats of adsorption CO and O_2 and heat liberated during the catalytic reaction on a cuprous oxide film formed on copper were measured at room temperature and the kinetics of the reactions were studied. Electrical conductivity of thin films of oxides was measured during reduction and the process of embrittlement studied. Effect of adsorption of gases on surface conductivity was investigated. 20 ref.—BLR.

1.8, 6.3

Reduction of Thin Films of Copper Oxide. (In French.) W. E. Garner, T. J. Gray, and F. S. Stone. *Bulletin de la Societe Chimique de France,* **1949,** D177-D182, Mar.-Apr.

Copper oxide films were prepared by alternate oxidation and reduction. Changes taking place were followed by variations in gas pressure and electrical resistance, and by microscopic examination. Kinetics of the reaction were studied on the basis of heats of adsorption determined for O_2, CO, H_2, and CO_2. Results are illustrated by photo-micrographs and shown diagrammatically.—BLR.

1.8, 3.6

The Mechanism of Electrode Processes in Aqueous Solutions. A. Hickling. *Quarterly Reviews (Chemical Society),* **3,** No. 2, 95-125 (1949).

A review based on 122 references. Experimental methods; electrode kinetics and polarization phenomena; cathodic evolution of hydrogen; anodic evolution

of oxygen; electrolytic oxidation and reduction processes; cathodic deposition and anodic dissolution of metals. Processes occurring at the dropping-mercury electrode in polarography are not dealt with.

1.8

Distribution of Thorium Isotopes Between Crystals of Lanthanum Fluoride and Their Saturated Solutions in 3 and 12% HNO_3 at a Temperature of 100° C. (In Russian.) V. G. Khlopin and M. S. Merkulova. *Doklady Akademii Nauk SSSR (Reports of the Academy of Sciences of the USSR)*, new ser., **65**, 861-864 (1949) Apr. 21.—BLR.

PREVENTIVE MEASURES

• Surface Treatment

5.9, 8.9

Phosphating Sheet Steel Before Painting. Premier Congr's Tech. *Internat. Ind. Peint.*, Paris, **1947**, 276-7.

The importance of phosphating is stressed. The process of preparation and painting used by the Ford Motor Co. is described.—RPI.

5.9

Chromium Impregnation (of Steel). F. C. Kelley. *Metals Handbook*, ASM, **1948**, 705-706.

Chromizing consists essentially in packing the steel in a mixture of alumina (45%) and chromium (55%) and heating to 2375°-2550° F (1300°-1400°C) for 3-4 hours in a hydrogen atmosphere. Other possible methods are also mentioned.—MA.

5.9

Quantitative Analysis of the Resistance to Corrosion of Phosphate Coatings. R. Krause. PB. 70039. Frames 6220-39+. *Prev. Det. Abs.*, **5**, Met. 150 (1948).

The protective value of phosphate coatings is determined from the loss of weight after pickling of corroded and uncorroded phosphated metal sheets. The thickness of the phosphate layer is influenced by changes in temperature and in iron content of the immersion bath.—RPI.

5.9

Rust. M. Lewis. *Prod. Fin.* (London), **2**, No. 1, 30-5+ (1949).

Bonderising and Parkerising are suggested as remedies for rusting of mild steel. Both processes are explained and discussed. The performances under salt spray, humidity and atmospheric conditions of Bonderised and non-Bonderised mild steel coated with various synthetic stoved enamels, are tabulated.—RPI.

5.9

Combination Cleaner and Phosphate Coating Compound. *Machinery*, **55**, No. 9, 168 (1949) May.

Detrex 79, a yellow non-corrosive cleaning and phosphate coating material designed to provide a base coating on steel and other ferrous metals preparatory to painting is a dust free powder which when used in heated water solutions at low concentrations, produces a light crystalline phosphate film on metal parts. Surfaces treated with this compound provide a better paint bond, and after painting show exceptional rust inhibition properties under salt spray tests.—INCO.

5.9

How to Clean Ferrous Metal Parts. R. Mansell. *Machinery*, **55**, No. 10, 194-196 (1949) June.

Methods used to remove grease or slushing compounds include solvent cleaners, steam cleaning equipment, phosphoric acid cleaners, vapor degreasing equipment and alkaline cleaners. Of these, solvent cleaners are probably the most frequently used.—INCO.

5.9

Liquid Blasting Cleans and Finishes Metallic and Non-Metallic Surfaces. B. H. Marks. *Mat. & Meth.*, **29**, 64-67 (1949) Apr.

Shows how surface blasting with a high-velocity stream of abrasive particles suspended in liquid provides an economical means of deburring, descaling, and preparing surfaces for finishes. Equipment and procedures are illustrated.—BLR.

5.9

Chromizing of Iron and Steel. M. Marmack. *The Australasian Eng.*, **41**, 39-48 (1948) Sept. 7.

Chromizing is a process in which chromium is diffused into the surface of iron or steel producing a chromium-rich surface layer. The significance of this process is that the chromium diffusion layer produced on the surface of the steel is extremely cor-

CPS HAS THE MATERIALS . . . KNOW-HOW . . . FACILITIES TO . . .

STOP THAT CORROSION!

ON LAND! Pipelines, Tank Bottoms, Gathering Systems, Gas & Water Distribution Systems

*ON SEA! Offshore Drilling Platforms, Offshore Pipe Lines, Wharves, Piers, Ships, Barges, Drydocks, Wellheads

IN THE AIR! Water Tanks, Condenser Heads

CPS OFFERS A complete sales, engineering and installation service

1. FIRST LINE MATERIALS
2. YEARS OF "KNOW-HOW"
3. COMPLETE FACILITIES

CPS handles only first line materials made by famous well known manufacturers. DOWELL Magnesium Anodes — GENERAL ELECTRIC Rectifiers — MALONEY Insulating Materials —M-SCOPE Pipe and Cable Finders — CADWELD Welding Supplies — RUBICON Potentiometers—Soil Resistivity Apparatus—HOLLOWAY Shunts—Miscellaneous instruments.

* These structures are usually protected most economically by a combination of CATHODIC PROTECTION and the ELECTRO-COATING PROCESS to which CPS holds exclusive license under U. S. Patent Numbers 2,200,469 and 2,417,064.

CATHODIC PROTECTION SERVICE

HOUSTON, TEXAS
4601 Stanford
Phone JA-5171

CPS

TULSA, OKLAHOMA
310 Thompson Bldg.
Phone 2-9857

Everything in the Cathodic Protection Field from an Insulating Washer to a Turnkey Contract Installation

rosion resistant owing to the high chromium content generally obtained. In the production of a chromized layer two basic processes are involved, namely (a) the supply of chromium to the surface to be treated and (b) the diffusion of chromium from that surface, forming a chromium-rich layer. With regard to (a), there are three methods available for supplying chromium to the surface to be treated, namely (1) the solid phase method, (2) the gaseous phase method, and (3) the liquid phase method. The advantages of the solid phase method are few, lying probably only in its simplicity. The disadvantages are the inherent non-uniformity of the layer produced, the extremely high temperatures and prolonged times necessary, and the increase in dimensions which take place. In the gas phase method a special carrier substance is used which is capable of absorbing chromous chloride ($CrCl_2$) and subsequently gives it up in the process, the articles to be chromized being packed in active mass and heated to 1,000-1,050° C in a hydrogen atmosphere. The great advantage of this method compared with solid-phase methods is that deeper chromized layers can be produced with lower temperatures shorter times (4 hours). The disadvantage is that special steels, usually containing titanium, are necessary for the process. In the liquid phase method the chromous chloride is contained in a salt bath containing the chlorides of barium, calcium, or magnesium. The great advantage of the liquid phase processes over the gaseous is that thicker layers can be produced under the same conditions of time and temperature. The concentration of the chromous chloride can be varied at will and special agents added to accelerate the processes, depending on the composition of the steel being treated. Extremely uniform layers are produced as compared with other methods. Because the chromizing process involves diffusion, the layer is intimately connected with the steel base and is therefore essentially free from the cracks and pits associated with electro-plated layers. The layers have good resistance to salt spray, steam and atmospheric conditions. The heat or scale resistance is high, the upper limit being generally placed at 800° C.—TIME.

5.9

Equipment for the Finishing Department. *Metals Rev.*, **20**, 9-15+ (1947) June.

Reviews 149 new products and processes for cleaning, rustproofing, coating, and plating reported during 1946. Includes list of manufacturers names and addresses.—BLR.

5.9

Anti-Corrosive Processes Based on Chromates. Metallgesellschaft. Board of Trade, Ger. Div. FD. 5036/47.—RPI.

5.9

Electrolytic Phosphating. Metallgesellschaft. Board of Trade, Ger. Div., FD. 4919/47.—RPI.

5.9

Report on Two Phosphating Processes Based on Chlorate for the Anti-Corrosion Proofing of Metals. Metallgesellschaft. Board of Trade, Ger. Div., FD. 5056/47, Frames 1-39.—RPI.

5.9

Antox III Process for Pre-Treatment in the Lacquering of Band Steel. Metallgesellschaft. Board of Trade, Ger. Div., FD. 671/48.—RPI.

5.9

Electro-Plating and Anodizing (Ed. 4). E. Molloy (Editor). Pub. by George Newnes, Ltd., Tower House, Southampton St., Strand, London, W. C. 2, England, 230 pages. *Metals Rev.*, **22**, No. 3, 33 (1949) Mar.

This book contains a brief historical survey and general theory of the electroplating process. Industrial applications and techniques adopted for the electrodeposition of various metals are given, as well as types of equipment and plant layout. The causes and cures of troubles with nickel and chromium plating solutions are described, as are the electroplating of hardware, and anodizing of aluminum, and the testing of finished work.—ALL.

5.9

Anti-Corrosive Treatments for Light Alloys. R. Mordaunt. *Mass Prod.*, **25**, No. 4, 54-55, 92 (1949). A brief review.—MA.

5.9

New Processes for the Surface Protection of Light-Metal (Magnesium) Alloys. E. Nachtigall. *Arch. Metallkunde*, 1, No. 5, 242 (1947).

Presented at a symposium on "Present-Day Corrosion Protection of Metallic Materials," held at Bitterfeld in Nov., 1946. A brief review of the production of protective films, on cast and

Complete Corrosion Prevention Sales and Service

In addition to outstanding corrosion prevention materials, JAMES E. MAVOR COMPANY offers you the services and facilities of an experienced organization for the solution of your corrosion problems.

Men who have spent years in corrosion research . . . and in the development of corrosion prevention products . . . are at your service.

With adequate stocks maintained at Houston . . . plus the advantage of our suppliers' strategically located manufacturing plants . . . we can make prompt shipment in any quantities.

Our traffic department "follows-thru" on all shipments . . . our job does not end until the materials are applied.

KOPPERS BITUMASTIC
Hot Applied Pipe Line Coatings
Manufactured at: Houston, Texas Woodward, Ala.; East St. Louis, Ill.; Chicago, Ill.; Follansbee, West Va.; Garwood, N. J.
Cold Applied Coatings
Stocked at Houston for immediate shipment

Carey
Asbestos Pipe Line Felt
Direct from factory shipment
Also stocked at Houston for immediate delivery

TAPECOAT
Protective Coatings for Pipe Joints
Stocked at Houston for immediate shipment

JAMES E. MAVOR COMPANY
march in new york
514 M & M Bldg., CApitol-2203
T. F. P. KELLY
HOUSTON 2, TEXAS

PRIMARY SOURCES OF ABSTRACTS PUBLISHED IN CORROSION

AER—Aeronautical Engineering Review, Institute of Aeronautical Sciences, Inc. 2 East 64th St., New York 21, N. Y.
ALL—The Abstract Bulletin, Aluminum Laboratories, Ltd. P. O. Box 84, Kingston, Onatrio, Canada.
AWWA—Journal, American Water Works Association. Amer. Water Works Assoc., 500 5th Ave., New York 18, N. Y.
BLR—Battelle Library Review, Battelle Memorial Institute Library. 505 King Ave., Columbus, Ohio.
BNF—Bulletin; British Non-Ferrous Metals Research Association. 81-91 Euston St., London NW 1, England.
CALCO—Calco Chemical Division, American Cyanamid Corp. Bound Brook, New Jersey.
CE—Chemical Engineering, McGraw Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.
CEC—Consolidated Edison Co. of New York, Inc. 4 Irving Place, New York 3, New York.
EW—Electrical World, McGraw-Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.
GPC—General Petroleum Corp. of California. 2525 East 37th St., Los Angeles 11, Calif.
INCO—The International Nickel Co., Inc. 67 Wall Street, New York 5, New York.
IP—Institute of Petroleum. 26 Portland Place, London W#1, England.
MA—Metallurgical Abstracts, Institute of Metals, London, England. 4 Grosvenor Gardens, London SW 1, England.
ME—Marine Engineering, The Institute of Marine Engineers. 85/88 The Minories, London E. C. 3, England.
MR—Metals Review, American Society of Metals. 7301 Euclid Ave., Cleveland 3, Ohio.
NALCO—National Aluminate Corp. 6216 West 66th Place, Chicago 38, Illinois.
NBS—National Bureau of Standards. Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C.
PDA—Prevention Deterioration Abstracts, National Research Council, 2101 Constitution Ave., Washington 25, D. C.
RA—Refrigeration Abstracts, American Society of Refrigeration Engineers. 40 West 40th St., New York 18, N. Y.
RM—Revue de Metallurgie, Paris, France. 5 Cite Pigalle, Paris (9e), France.
RPI—Review of Current Literature Relating to the Paint, Colour, Varnish and Allied Industries, Research Association of British Paint, Colour & Varnish Manufacturers, London. Waldegrave Rd., Teddington, Middlesex.
TDD—Technical Data Digest, Air Material Command—Technical Service Section, Central Air Documents Office, Wright-Patterson Air Force Base, Dayton, Ohio.
TIME—Transactions of Institute of Marine Engineers. 85 The Minories, London EC 3, England.
UOP—Universal Oil Products. 310 South Michigan Ave., Chicago, Illinois.
ZDA—Zinc Development Association. Lincoln House, Turl Street, Oxford, England.
No Code—Current Technical Literature, Bell Telephone Laboratories. 463 West Street, New York 14, New York.

wrought magnesium alloys, by chemical and anodic-oxidation processes.—MA.

5.9

Protective Anti-Corrosive Layers on Aluminum and its Alloys. Neunzig. PB. 70019, Frames 11372-83; *Prev. Det. Abs.*, **5**, Met. 195 (1948).

A protective coating can be produced on aluminum and aluminum copper bearing alloys by a 2-3 day treatment with conc. NH_4OH at room temperature. The metal can then be lacquered. The lacquered and unlacquered ammonia-treated metal will withstand severe corrosion tests.—RPI.

5.9

Corrosion Protection of Aluminum of Various Degrees of Purity and Various Heat Treatments by a Short MBV Treatment (Chemical Oxidation). Neunzig. PB. 73872, Frames 14666-75; *Prev. Det. Abs.*, **6**, Met 17 (1949).—RPI.

5.9

Solubility of Protective Coatings on Light Metal Sheets Pretreated in Various Ways. Nicolini. PB. 70191, Frames 2463-4; *Prev. Det. Abs.*, **5**, Met. 198 (1948).

Of the various pretreatments to which pure aluminum sheets were subjected before painting and exposure, sandblasting invariably gave inferior results. On natural weathering, anodizing and NH_3 treatment were superior, to bright rolling of the MBV treatment as pretreatments.—RPI.

5.9

Seomag Processes for the Production of Corrosion Resistant Coatings on Magnesium Alloys. Ralph M. Osborne, U. S. Office of Military Government for Germany FIAT Technical Bulletin T-23; PB-78989 (1947) Apr.

Two electrolytic coating processes, Seomag W and Seomag G, for magnesium alloys were developed by Siemens & Halske Co. of Germany. The corrosion resistance of the resulting coatings can be improved by waxing or oiling or, preferably by lacquering. Both coatings can be dyed. They have, however, few advantages over straight chemically-produced coatings and are more expensive.

The Seomag W a-c process treats equal areas of magnesium anodes and cathode in an aqueous solution containing 10 kg neutral potassium fluoride, 6 kg sodium aluminate, and 3 kg tertiary sodium phosphate per 100 liters. The operating temperature of the bath is 20-40° C, the time required to produce coatings 20-40 μ thick is about a half hour and the voltage is gradually built up to 70 producing a current density of 1.5 amp. per sq. dm. The resulting coating is white when the alloy contains aluminum and pink when manganese is present. It is harder than the oxide coating on aluminum, but is brittle and cracks on bending.

The Seomag G d-c process operates with a bath containing 10 kg sodium hydroxide, 6 kg potassium cyanide, and 5 kg anhydrous sodium carbonate in 100 liters of aqueous solution. The treated articles serve as the anode. The temperature is held at 60-65° C, the voltage at 4-6 volts corresponding to a current density of 1.5-2.0 amp. per sq. dm, and the time required to produce a coating 10-20 μ thick is 35-45 min. On aluminum alloys the resultant coating is gray, but pink when manganese is present. Seomag G coatings are softer than those made by the Seomag W process.

PDC Comment: According to a survey on file at the Center, of German practices in metal finishing during recent years, the potassium salts instead of the sodium salts are used in the Seomag W bath. (British Intelligence Objectives Sub-Committee. The German Metal Finishing Industry, B.I.O.S Final Report No. 1615. Item No. 21, p. 132-133, 1946, B-363).—PDA.

5.9

Importance of Chemical Surface Treatments for Steel and Iron. G. Roesner. PB. 70040, Frames 6740-65. *Prev. Det. Abs.*, **5**, Met. 165-6 (1948).

A general review of German practice in inorg. surface treatments for steel and iron. Surface layers must be thinner and finer grained than normal if the article is to be lacquered. Phosphating provides an excellent primer for varnishing.—RPI.

5.9

Method for the Production of Black Corrosion Resistant Coatings on Surfaces of Objects Made of Aluminum and Aluminum Alloys. J. L. Reschke and Koniarski. PB. 70018, Frames 10158-62. *Prev. Det. Abs.*, **5**, Met. 177 (1948).—RPI.

5.9

Aluminum Impregnation (of Steels). B. J. Sayles. *Metals Handbook*, ASM **1948**, 703-704.

Methods of Calorizing and the properties of the coating produced are briefly described.—MA.

5.9

Rust Prevention with Chromic Acid. A. Schall. PB. 70039; Frames 6034-55; *Prev. Det. Abs.*, **5**, Met. 145 (1948).

Treatment of metal surfaces with chromic acid (methods and variations described) before lacquering resulted in a highly corrosion-resistant system.—RPI.

5.9

Corrosion Resistance of Cold Phosphated Steel. G. Schikorr. *Archiv fur Metallkunde*, **3**, No. 2, 82-83 (1949). *Electroplating*, **2**, No. 7, 478 (1949) July.

Sea water spray and atmospheric exposure tests show that cold phosphated and cold phosphated and oiled steel specimens have same corrosion resistance as similar specimens treated by corresponding hot phosphating processes. Oiling without phosphating had very little protective value. Conclusion is reached that when using a cold phosphating process it is more than ever essential thoroughly to degrease the metal.—INCO.

5.9

Protection against Corrosion of Zinc and Zinc Alloys with a Bright Metallic Surface. H. D. Schweinitz, V. Graf and G. Wassermann. PB. 70040, Frames 7216-30; *Prev. Det. Abs.*, **5**, Met. 147 (1948).

Treatment of zinc metal and alloy surface with sodium silicate solutions produces a film about equal to phosphate and chromate layers in corrosion protection, but inferior as a base for lacquers.—RPI.

5.9

Chromizing and Chromizing Combined with Calorizing of Tubular Products. M. K. Shelud'ko. *Stal*, **7**, No. 6, 519-523 (1947).

Data on improved chromizing process including composition of chromizing compound, chromizing temperature and time, and case thickness obtained. Tests were made on different lots of chromized tubes, destined for use in ships, condensers, exhaust pipe, and nitric acid installations. Detrimental effect of cold working of chromized tubes, superiority of chromized exhaust pipe made of 0.12 C, 5 Cr, 0.25 Mo steel over unchromized 18-8 Ti steel, chromizing combined with aluminizing for increased heat resistance, steel tubes so treated and results of tests for heat resistance are discussed. 10 references.—INCO.

5.9

Brush Anodic Films Onto Local Areas. E. Simon and F. W. Thomas, Lockheed Aircraft Corp., Burbank, Cal. *Am. Machinist*, **92**, No. 14, 103-105 (1948) July.

Local areas of aluminum or magnesium surfaces denuded of a protective anodic film can be quickly repaired by brush anodizing without dismantling the assembly. A simple portable equipment is used for small repairs. It consists of an anode terminal clamped or otherwise fastened to the work, a pressure feed tank supplying chromic acid solution to a brush anodizing gun or cathode, a voltage control, and a manometer. Brush heads of various appropriate styles can be screwed into the gun head, and the flow of the electrolyte controlled by a trigger. To repair fairly large areas, an electrolyte pad soaked with a saturated aqueous solution of sodium bisulfate and a lead or aluminum sheet cathode are fastened to the work.

For most brush work on duralumin, the electrolyte contains 3-5% by weight of chromic acid. For magnesium, the electrolyte should consist of mixtures of ammonium hydroxide, tungstates and vanadates and chromic acid, adjusted to pH 7. Low concentrations of electrolyte require an excessive number of brush strokes, high concentrations produce excessive heating, arcing, and pitting. Temperature, voltage, and current density are governed by the working area and the type of power supply. The power lead from the gun is connected either to a 75-150 volt d-c generator or to a Variac voltage regulator connected to a 110 volt a-c source. Normal a-c line voltage of 110 volts or less gives as good results as d-c current when a 3% aqueous chromic acid solution is used. Only a few seconds are required to produce a brushed anodic film since current densities are about 250-1000 times greater than in tank-immersion processes.

Brush anodizing is not restricted to repair jobs. It may be used on parts of an assembly incapable of being tank anodized. On duralumin, e.g., anodic films produced by this method give increased adhesion to primers, paints, and resinous adhesives. On magnesium the corrosion resistance of these films is comparable with that of a chrome-pickle treatment. —PDA.

5.9

Experiments on the Chemical Production of Thick, Protective Inorganic Surface Film (of Magnesium Fluoride) on Magnesium (and its Alloys). M. Staesche. *Arch. Metallkunde*, **1**, No. 5, 242-243 (1947).

Presented at a symposium on "Present-Day Corrosion Protection of Metallic Materials," held at Bitterfeld, in Nov. 1946. Dense, highly resistant, protective films (10-30 μ thick) of magnesium fluoride can be formed on magnesium alloys containing aluminum (3, 6, or 8%), manganese, or manganese and cerium, by immersion in hot sodium hydroxide solutions followed by subsequent treatment in hot solutions containing alkalis and alkaline-earth fluorides or silicofluorides. The resulting coatings are resistant to 30 days' immersion in oxidizing sea water; they are practically unchanged after exposure to normal atmospheres for 1½ years. With the exception of the alloy containing 6% aluminum, sheets having such protective coatings do not ignite at 540° C.—MA.

5.9

Phosphate Coatings in Industry. G. S. Wallis. *Paint Notes*, **4**, No. 1, 10-19 (1949).

The use of phosphate coatings on iron is traced historically. The production of light phosphate coatings, which are essentially paint bases, is considered in some detail, and their advantages are discussed.—RPI.

5.9

Electrolytic Pickling. Konrad Weller. *Metal Fin.*, **46**, 95-102 (1948) June. Translated from the German by Dr. J. C. Bacon.

Fundamental electrochemical principles are surveyed from patents relating to the various types of electrolytic pickling processes, viz, (1) anodic pickling, (2) cathodic pickling, (3) pickling with changing polarity or by alternating current, and (4) pickling in a conducting medium.

In anodic pickling the attack of the metal surface is accelerated, thereby rapidly reducing the mechanical oxide-to-metal bond. In cathodic pickling the hydrogen liberated by the acid used in the bath increases many fold the loosening of the oxide scale, but also increases the possibility of embrittlement. The alternating polarity or alternating current process successively combines and accentuates both of these loosening actions. When a conducting medium is used for pickling, both anodic and cathodic effects are obtained simultaneously by suspending in an electrolyte between electrodes without directly connecting the work to current.

Electrolytic pickling occupies a position intermediate between electrolytic degreasing or cleaning and electrolytic polishing, with a gradual transition between the various surface treatments. The degreasing and cleaning depend upon the liberation of hydrogen on the

MAN FROM MARS?

This queer-appearing fellow might have stepped out of a movie of another world, but actually he is only one of a trained NATASCO Crew. Protected by specially designed clothes, he sandblasts such surfaces of tanks as require this treatment before NATASCO corrosion prevention products are applied. He is just one of a crew of skilled men, with equipment built for each specific task, who will make money for you by protecting your tanks against corrosion.

Every NATASCO job is Guaranteed

A post card will bring complete information about NATASCO SERVICES

PROTECTS TANKS AGAINST CORROSION — THE Natasco COMPANY — P. O. BOX 1310 — TULSA, OKLAHOMA

march in new york

Lease Tank Service—West Texas Area: Williams Construction Company, Odessa, Texas

California Representative: Coast Contractors, Ltd. 4636 E. Slauson, Maywood, Cal.

metal piece, loosening impurities in much the same way as does cathodic pickling. Anodic pickling, on the other hand, depends on the combined action of metal solution and oxygen liberation; this can be modified for a polishing or shining action by using a high current density.

Many advantages of electrolytic pickling over chemical pickling are pointed out. The former requires a shorter pickling time and is readily applicable to stainless steel. It does not require strong acids, and the baths used are quite insensitive to high concentrations of iron salts. Because weaker and smaller amounts of acids are needed and the life of the bath is longer, the disposal of pickling residues is less difficult. Almost no metal loss is introduced and cathodic deposition of dissolved iron and recovery of free acid is possible. In spite of these advantages the low plant-installation costs and simple manipulation involved in chemical pickling recommend it to many.—PDA.

5.9

Sherardizing. Zinc Development Association. *Z.D.A. Tech. Memo.,* No. 10, 10 pp. (1948) Dec. Issued by the Association, Turl Street, Oxford. B.N.F. Serial 30, 847c.

Describes the nature of the process, equipment and materials used; applications; corrosion resistance; subsequent finishing; tests and specifications. 16 references.—BNF.

5.9

Tropical Program on Protective Finishes for Caliber .45 Ammunition. C. L. Rammel, U. S. Frankford Arsenal, Philadelphia, Report No. R-881 (1949) Jan.

Ammunition of .45 caliber was exposed in an unprotected and protected jungle atmosphere and indoors for 7 months during the rainy season to determine corrosion resistance of brass and of coated steel in a wet tropical climate. Brass ammunition cases were more resistant than were those of steel, having either a phenol-formaldehyde coating or a zinc-cronak finish.

Corrosion products accumulated over the entire surface of steel cases strewn on the jungle floor without protection. About 6% of those coated with phenol-formaldehyde were perforated. The zinc-cronak cases were extensively rusted but showed no perforations. Under the same conditions, the brass cases were only stained. Rounds were slow and irregular in firing due to heavy corrosion deposits on the cases. The brass rounds were least affected; these were followed in order by phenol-formaldehyde and zinc-cronak treated steel rounds. Only 30% of the brass cases were found split after firing as compared with 80% of the zinc-cronak and 97% of the varnished steel cases. Misfires caused by the presence of moisture in the primer, however, occurred more frequently among the brass than among the steel cases.

Rounds exposed to protected jungle environment were in open cardboard containers placed on a wooden rack 2 feet above the ground in a densely forested area and covered by a slanting roof. After 7 months they were in fair condition, brass cases showing mild discoloration with slight roughening and coated steel exhibiting roughening and superficial corrosion.

Rounds subjected to indoor exposure were kept in 50-round cardboard containers stored 1 foot above the cement floor of a metal magazine. They were in good condition with the exception of a few zinc-cronak steel cases which showed mild corrosion deposits and slight etching.

The thickness of the zinc plate used on the cases varied from 0.0002 to 0.0004 in., the AXS unmodified, heat-reactive phenolic varnish coating from 0.0003-0.0006 in. Fifty rounds of each type were fired monthly for each exposure condition.—PDA.

5.9

Rust Layers as Adhesion-Promoting Surfaces for Painting. H. Ketterl. *Farbe u. Lack,* **55,** No. 2, 40-7 (1949).

Rust formed on ferrous surfaces under carefully controlled conditions, dried out and stabilized, is of great value as an intermediate layer between paint and metal surface. Such a layer may be formed by mild superficial corrosion, e.g., by steam, followed by heating. It is thin, hard, and not water-retentive. The process may be applied to any steel surface.—RPI.

5.9

Effect on Subsequent Varnishing of an After-Rinsing of Bonderising Coatings with Aluminum Oxalate. A. Schall. PB. 70041, Microfilm Rel. No. H 45, Frames 7606-16; Board of Trade, Ger. Div., FDX. 450 (1949) p. 3.

Sheets were rinsed with various aluminum oxalate solns. and varnished and then exposed to corrosive agents. The favorable or harmful effect proved to be dependent on the kind of varnish film and type of corrosion stress.—RPI.

5.9

Zinc Impregnation (of Iron). F. C. Kelley. *Metals Handbook,* ASM, 1948, 715-716.

The process of Sherardizing is described, in which the iron or steel is packed in zinc powder in tightly sealed drums and heated at 660°-700° F (350°-370° C) for 3-12 hours. The principal application of Sherardizing is for small steel parts (bolts, nuts, washers, etc.) or for castings which must resist the action of the atmosphere.—MA.

EQUIPMENT

• Coils and Heat Exchangers

7.4

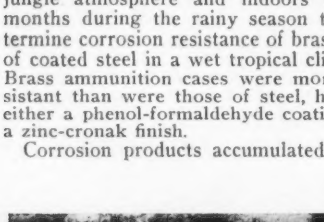
A Study of the Cause of Hard Slag Deposits on Firesides of Naval Boilers. L. C. McCloskey. *J. the Amer. Soc. of Naval Eng.,* **59,** 146-164 (1947) May.

Gives results of a study of a type of deposit on superheating tubes which has caused much trouble in the Navy. Discusses the chemical and physical nature of the deposits; fuel and boiler design characteristics; burner design; theoretical considerations concerning atomization and behavior of small particles in gas streams and films; the probable sequence of events in slag formation; the cause of slagging; means for reducing the incidence of slag formation; and methods for removal of deposits. Good photographs illustrate the condition.—BLR.

7.4

Recent Research on Caustic Cracking in Boilers. Paper by Dr. C. D. Weir, read at a Meeting of the Institution of Engineers and Shipbuilders in Scotland (1948) Nov. 30.

In this paper the author describes the characteristics of caustic cracking and gives an account of recent research in the laboratory and under operating conditions. He then discusses the various theories which have been advanced from time to time to account for the mechanism of this type of failure. The suggestion is made that some light is perhaps thrown on the whole problem by a simple investigation into the similar type of attack occurring in hot ammonium nitrate solutions recently carried out by the author. In these experiments, U-bend specimens were subjected to the action of ammonium nitrate solutions in the region of the boiling point, provision being


DOLLARS and SENSE of Cathodic Protection
FOR TRANSMISSION AND DISTRIBUTION PIPELINES
Installation Crew at work installing anodes.
"In this day and age when the effectiveness of cathodic protection is so well established," you can:
✓ Eliminate Line Depreciation;
✓ Reduce Maintenance;
✓ Check Loss of Product Due to Leaks;
✓ Protect Good Will;
✓ Save Revenue Lost Through Service Interruptions;
✓ Lower Product Liability Insurance Cost.
Write today for new booklet
Electro Rust-Proofing has facilities and equipment for Surveys, Design, and Installation.
ELECTRO RUST-PROOFING CORP.,(N.J.)
BELLEVILLE 9, NEW JERSEY
REPRESENTED IN PRINCIPAL CITIES
E-13

made for polarizing the specimens. It was found that unpolarized-specimens and those polarized anodically at a very low cuurrent (less than 1 milli-ampere) were deeply cracked in the course of a few hours; the cracks were intercrystalline. At higher anodic currents only heavy surface oxidation, accompanied by slight fissuring, was observed. Specimens polarized cathodically at low current densities showed a type of attack similar to that of unpolarized specimens, though in general the cracks were somewhat finer. At current densities sufficiently high to afford apparently complete cathodic protection, shallow and extremely fine surface cracks were produced. It seems probable that, under the circumstances, these latter can only be attributed to the occlusion of hydrogen by the specimens. If the similarity between ammonium nitrate and caustic cracking is accepted as being real and not merely apparent, these results appear to offer a plausible explanation of the mechanism whereby caustic cracks are produced. In the initial stages of the attack of concentrated alkali on steel a non-protective oxide film is formed, the process being accompanied by the formation and partial occlusion of hydrogen. The resultant hydrogen embrittlement of the metal gives rise to fine intergranular surface cracks at severely stressed and distorted areas of the metal surface. Subsequent penetration of these cracks by the alkali results in the beginning of a process of anodic corrosion in the manner envisaged by Evans. The cracks are thus widened and extended, giving rise to the typical intergranular fissures. The corrosion process continuing in the fissure facilitates, in company with the applied stress, its propagation through the distorted and embrittled metal until finally rupture occurs. Thus the occlusion of hydrogen is necessary for the initiation of attack, and accounts for its propagation in an intergranular manner. On the other hand, propagation can occur only under circumstances which permit the continuance of an anodic corrosion process. As far as attack in sodium hydroxide solutions is concerned, it is to be noted that, while anodic polarization at low current densities does not preclude the possibility of sufficient hydrogen being formed through the medium of local action cells to permit the onset of attack, and will indeed hasten it in its larger stages, cathodic polarization may sufficiently reduce anodic attack to prevent failure altogether.—TIME.

7.4

Economizers and Air Heaters. D. M. Schoenfeld and E. P. Worthen. Paper before Soc. Naval Architects & Marine Engrs., Jan. 1949, New England Section. *Marine Eng. Shipping Rev.*, **54**, No. 5, 71-76 (1949) May.

Internal corrosion of economizers can be prevented by proper installation and operation of equipment to deaerate the feedwater. The design features of economizers and air heaters for application to marine boilers are compared, pointing out the influence on the final design selection of the steam cycle, desired performance, operation and maintenance.—INCO.

7.4

Deposit Formations on Boiler Tubes. R. S. Young and A. J. Hall, Central Laboratory, Nkana, Northern Rhodesia. *Combustion*, **20**, No. 1, 41 (1949) Jan.

At a power plant in Northern Rhodesia barnacle formation on boiler tubes and drums, with pitting underneath, was attributed to slow cooling and long standing of the boilers before draining. Further investigation indicated that the presence of phosphate and sulphate in the boiler water was necessary for barnacle formation. Presence of copper salts seemed to accelerate the action. The authors recommend emptying boilers as soon as practicable after shutting down. —NALCO.

7.4, 8.9, 6.2, 3.5, 3.3, 4.6

Fouling of Marine-Type Heat Exchangers. N. E. Bethon. *J. Amer. Soc. Naval Eng.*, **61**, 469-493 (1949) May.

Deals with the subject from point of view of combatant naval vessels. Design of heat exchangers, causes of fouling and design factor which minimize them, use of 70/30 Cupro-nickel tubes and tube sheets in main-turbine coolers and of same material for plate-and-strut-type tubes for Diesel generator sets (header plates also of 70/30 cupro-nickel) are discussed. Notes on performance of coolers, fouling, etc. and notes on use of Cu-Ni condenser tubes in main condensers and large turbine-driven auxiliaries are given. Main condensers to specifications of U. S. Maritime Commission vessels are usually of aluminum brass. BB61 class battleships have condensers with welded Monel water-boxes. Tubes and tube sheets are of 70-30 cupro-nickel. Notes on fouling of steam and water sides, and examples of condenser fouling are given. Construction and fouling of fuel-oil heaters and construction of distilling plants are discussed. Bureau of Ships now requires 70/30 for tubes and tube sheets. Fouling of distilling plants and British experience with distilling plant described. —INCO.

7.4

Marine Boiler Deterioration. I. G. Slater and N. L. Parr. *Engineer*, **187**, 158-161, 199-201 (1949) Feb. 11 and 18.

Forms of corrosion and deterioration encountered in water-tube and fire-tube marine boilers are illustrated and classified. Causes and methods of prevention are discussed. Includes (p. 159) a detailed tabular summary of forms of boiler deterioration.—BNF.

7.4, 3.4

Corrosion of High-Pressure Steam Generators. Status of Our Knowledge of the Effect of Copper and Iron Oxide Deposits in Steam Generating Tubes. *Proc. ASTM*, **48**, 907-941 (1948).

Critical review of published work correlated with author's experience and with theoretical data. No generally accepted theory. Combined bibliography of 30 references to this and previous note.—BNF.

7.4, 4.3, 2.3

Causes of Flue Gas Deposits and Corrosion in Modern Boiler Plants. W. F. Harlow. *Engineer*, **187**, 271-273 (1949) Mar. 11; discussion, 277-279. A condensation.

Discusses the universal nature of the above problem, which, however, is much less serious in pulverized-coal installations. Summarizes experimental results which demonstrate that the most important cause of corrosion is the formation of SO_3 and resulting H_2SO_4 on passage of flue gases over heated boiler surfaces, especially at the higher temperatures. The test apparatus is diagramed. Effects of various factors including sulfur and

TAPECOAT*

The Time-Tested Coal Tar Coating in Handy Tape Form

...Sized to the Job

24"

Tapecoat in 24" width is the economical coal tar coating for "cigarette-wrapping" mechanical couplings.

18"

Tapecoat in 18" width—the size for "cigarette-wrapping" sleeves, large pipe bends and joints on large diameter pipe.

6"

4"

3"

2"

Tapecoat in 6", 4", 3" and 2" widths —ideal for spiral-wrapping welded field joints, service connections, pipe under streets and sidewalks, and pipe through building walls, etc.

Write for full details and prices on Tapecoat —the coal tar coating with a width for every purpose.

* Reg. U. S. Pat. Off.

The TAPECOAT Company

1523 Lyons Street, Evanston, Illinois

489 Fifth Avenue, New York 17, N.Y.; Jas. E. Mavor Co., 514 M and M Building, Houston 2, Texas; 175 Niagara Street, Denver 7, Colo.

impurity content were determined. Practical means of minimization are discussed.—BLR.

7.4

Unusual Corrosion in High Pressure Boilers. S. T. Powell and L. G. von Lossberg. Paper before NACE, St. Louis, Apr. 5-8, 1948. *Corrosion,* **5,** No. 3, 71-78 (1949) Mar.

Description of corrosion embrittlement points out that corrosion embrittlement can occur in high pressure boilers using chemically treated or evaporated make-up. It is characterized by corrosion of metal beneath a hard, dense scale of black magnetic iron oxide. Mechanism is explained as a result of sluggish circulation causing film boiling at temperature below crystallizing point of steel. Formations of adherent black magnetic iron-oxide beneath which corrosion embrittlement takes place is removed by acid cleaning which was successful when turbining of tubes failed to dislodge adherent iron oxide scale from corroded areas. Changes in operating conditions, such as increasing load can adversely affect boiler circulation in critical units causing failure of tubes due to high temperature creep. Caustic embrittlement can occur at tube joints in welded drum boilers designed to operate at, or above, 400 psi. Photomicrographs are included. —INCO.

7.4

Corrosion of Boiler Generating Tubes. R. L. Rees and E. A. Howes, British Electricity Authority. *Combustion,* **20,** No. 8, 49 (1949) Feb.

Corrosion occurred at the expanded tube ends in the top of the central row of generating tubes in boilers of the London Power Company, Ltd., operating at 375 and 625 psi. It was noted that metallic copper was present in the corrosion product and that the ammonia content of the feedwater had increased. Increasing boiler water alkalinity from 40 to 50 ppm $CaCO_3$ above pH 8, and phosphate concentration from 8 to 20 ppm, has apparently stopped corrosion.—NALCO.

• Containers

7.5

Corrosion Phenomena in Connection with Steel Pressure Cylinders Used for Storage and Transport of Coal Gas. *Metallurgia,* **39,** 284 (1949) Mar.

Reviews some recent German work on the above.—BLR.

• Wires and Cables

7.8

Silicon Monoxide Protected Front-Surface Mirrors. G. Hass and N. W. Scott. *J. of the Optical Society of America,* **39,** No. 2, 179-184 (1949) Feb.

An evaporation method is described for producing front-surface mirrors with good abrasion, corrosion, and reflection qualities. Aluminum is used as the reflecting material because evaporated aluminum films have high reflectivity in all useful spectral ranges and show, in the electron microscope, a much finer grain and smoother surface than similar silver coatings. Since direct evaporation of SiO_2 is difficult and yields loose layers, a lower oxide of silicon, silicon monoxide, was investigated and found to produce good qualty protective films. Silicon monoxide evaporates at a much lower temperature than silicon or silicon dioxide and deposits on the mirror surface in uniform and adherent layers which, when exposed to the atmosphere, partially oxidize to SiO_2. The visual reflectivity of aluminum mirrors protected with an optimum thickness (about 1500A) of SiO is about 89 percent, or only one percent lower than that of the unprotected aluminum surface. In the infra-red from 2 μ to 8 μ these layers do not show any appreciable absorption; however, the absorption band characteristic of silicon oxides appears between 8 μ and 10 μ. In the ultraviolet the silicon-oxide layer shows absorption which varies with the evaporation conditions. This absorption can be decreased by an oxidizing treatment. The silicon-oxide protected mirror is unaffected by prolonged heating in air at 400° C (752° F), and is highly resistant to sea water, sodium hydroxide, and most acids. The silicon-oxide-protected mirror also shows good abrasion resistance. To produce mirrors on metallic bases it is advisable to use a silicon-oxide film as an intermediate layer because it improves adherence and prevents diffusion from base metal to reflecting layer. With the silicon-oxide evaporation method it is also possible to make protected front-surface mirrors on plastic materials. Evaporated SiO layers are also successfully used as replica and support films in the electron microscope.—ALL.

7.8. 4.3, 5.10

Preventing Corrosion in Relays. A. E. Herman, Allis-Chalmers Mfg. Co. *Elec. Mfg.,* **43,** No. 5, 116-118 (1949) May.

In partially sealed relays continuously operated, arcing at contacts may form HNO_3 and ozone which attack metal parts and organic compounds. Results show operating cycle will affect life of arcing device sealed under atmospheric conditions. If rate of operation is infrequent, corrosive atmosphere within device will dissipate itself and formation of acid salts will not occur. Only a small amount of ventilation is required for satisfactory operation for a continuous duty cycle.—INCO.

7.8

Cast Electrical Hardware for High Tension Lines. *Modern Metals,* **4,** No. 2, 36 (1948) Mar.

Discussion of corrosion and breakdown of high tension electrical strain clamps and suspension clamps. Failure due to corrosion and stress of iron and steel clamps were studied and were corrected by using cast aluminum. Illustrations of Al hardware are given.—INCO.

7.8

Aluminum Ropes. *Mining J.,* **232,** No. 5931, 298 (1949) Apr. 23.

The utilization of aluminum alloys as a non-corrosion product in wire rope construction is discussed. Producers of Wirelon, nylon-covered rope, claim the coat is unaffected by oils, marine growth, alkalies, and nitric, sulfuric, and hydrochloric acids solutions up to 1%.—INCO.

7.8

Aluminum in Road and Rail Transportation. A. Brinck. 140 pages, published by A. S. Nordisk Aluminumindustri, Oslo, 1948. (Translation by I. Grove, Banbury)

This book is concerned chiefly with the problems involved in the reduction of deadweight, inevitably found in all forms of transport. The value of mathematical analysis as a guide to such problems is stressed, and considerable attention is given to the economic complications which arise when, as a means of reducing weight, iron and steel are replaced by light metals and light alloys. Problems which are constantly arising in practice in the transport field are dealt with in the introduction, and in different sections dealing specifically with road transport, railway rolling stock and tramways, and with direct and indirect saving in weight, opportunities for making use of it, and the economic results involved. This book is attractively bound and is profusely illustrated.—ALL.

7.8

Aluminum Alloy Door Bolts. *British Trade J.,* **1948,** July. *Light Metal Age,* 6, Nos. 11-12, 23 (1948) Dec.

A door bolt made of a high grade, fully heat treated aluminum alloy has recently been introduced by the Barrel Bolt and Tool Co., Ltd., London. The bolt has been subjected to the anodic oxidation method of treatment, thus making it corrosion-proof in any climate. It is available in six colors, aluminum, gold, bronze, blue, green or black.—ALL.

7.8

Corrosion of Base Metal Contact Surfaces in the Telephone System. *Corrosion,* **5,** No. 4, 134 (1949) Apr.

Discussion of a new technique for improving performance of contacts in talking circuits of panel dial system. Laboratory tests show that frictional heat produced in the new equipment may raise temperature locally to melting point of metal. When this occurs, coating of oxides is produced on sliding surfaces. Oxides are responsible for resistance films over contacting area. Photographs illustrate the discussion.—INCO.

7.8

Thermostatic Steam Trap Has Stainless Bellows. *Heating, Piping & Air Cond.,* **21,** No. 4, 183 (1949) Apr.

Thermostatic steam traps have stainless steel bellows for pressures up to 300 psi and for corrosive condensate. Manufactured by Sarco Co., Inc.—INCO.

7.8

Stainless Chemical Meter. *Instruments,* **22,** No. 2, 149 (1949) Feb.

Stainless steel chemical meters for volumetric measurement of corrosive liquids such as caustic soda, acids and fruit juices. Meters have working parts of Type 316 stainless and castings of 316 stainless, cast iron, cast bronze or cast carbon steel. Manufactured by Buffalo Meter Co.—INCO.

7.8

Oil-Loading Docks in Venezuela Built of Welded Steel. T. T. Knappen. *Civil Eng.,* **19,** No. 3, 33-37 (1949) Mar.

To transport oil from Lake Maracaibo, the Creole Petroleum Corp. of Venezuela built a 145-mile pipeline to its refinery and loading piers. For ocean going tankers welded steel piers were constructed. Corrosion protection of the steel consists of Bitumastic coatings; concrete jackets on piles in the "between wind and water region"; and cathodic protection using galvanic anodes. Pier and harbor improvement required 10,000 tons of structural steel. Monel eye-bolts and thimbles are

used in suspending magnesium anodes from the structural steel.—INCO.

7.8
Corrosion Guide for Fasteners. *Prod. Eng.*, **20**, No. 7, 161 (1949) July.

Chart of corrosive liquids based on assumption that all metals listed will be such holding members as screws, bolts, studs and the like, is a guide to selection of proper fastener metal. Among metals listed are Monel, stainless steels, and copper.—INCO.

INDUSTRIES

• Group II

8.2
Experience at Bagnell Dam to Prevent Corrosion of Underwater Steel & Iron. T. White, Jr., Union Electric Co. of Missouri. Paper before NACE, Ann. Mtg., St. Louis, Apr. 5-8, 1948. *Corrosion*, **5**, No. 1, 25-26 (1949) Jan.

Only methods used in application of theories and experiences developed by others are presented in effort to find a satisfactory means of protecting steel and iron continuously submerged. Cathodic protection and use of two coats of aluminum paint applied on bright metal surface are discussed as successful means of corrosion prevention.—INCO.

8.2
Aluminum in the Electric Cable Industry. *Light Metal Age* (U. S. A.), **6**, No. 11 & 12, 14-19 (1948) Dec.

Part I: Aluminum for interior wiring is comparatively new in the United States, but has been used successfully on the continent for some years. Aluminum busbars, which operate under the most corrosive conditions, were used for transmitting electric power at the Niagara Falls Power Plant in 1895. Since 1909 it has been customary to use aluminum cables, steel reinforced (A.C.S.R.) for overhead power lines. The modern installation of aluminum busbars for electrical purposes includes steel mills, chemical plants, electro-chemical plants, storage battery rooms, central stations and substations. Because of its high electrical conductivity, aluminum wire is being used in the electrical industry; and the aircraft and construction industries find its extreme lightness, flexibility, high strength, and resistance to corrosion, moisture and weather of particular advantage. The same solder or mechanical methods of joining, connecting and terminating as used with copper may be used on aluminum building wire and cable. As far as current carrying capacity is concerned, aluminum has 84% of the current-carrying capacity of copper with the same kind of insulation. Part II: Aluminum as the sheathing material: The production of power cables sheathed in aluminum of commercial purity has only recently been perfected, using iron and silicon as the principal minor alloying constituents. Lead sheathed cables will not be superceded; however, an alternative sheathing material is now available that possesses properties not obtainable in cables covered with the softer lead, or even in the harder lead alloys which have been introduced. Other comparatively minor metallurgical and electrochemical differences between the light and heavy metal sheathing affect the design and increase the scope of particular systems of conduction.

• Group III

8.3, 5.7, 6.2, 4.4, 4.3, 6.1, 2.2
Food Investigation, 1947; Report of Food Investigation Board and of Director of Food Investigation, Department of Scientific and Industrial Research. (British) Published by H. M. S. O., pp 21, (1949).

Section dealing with corrosion of metals includes discussion of boiling-water treatment to enhance corrosion-resistance of aluminum, and tests of aluminum alloys against citric acid. Difficulty was found in determining most suitable material for containers for warm citrus juices and syrups containing small amounts of sulfurous acid. Most common metals are unsuitable. Corrosion tests designed to ascertain probable behavior of different types of stainless steel under factory conditions were carried out with a solution containing citric acid (4%), sodium chloride (0.5%), sugar (30%) and 700 ppm of sulfur dioxide, maintained at 60° C. The results divided the steels into two classes, resistant and non-resistant.—INCO.

8.3, 6.1
Nickel-Clad Steel Cookers Used in Modern R and H Brewhouse. *American Brewer*, (1949) Mar. Reprinted by INCO.

New unit of Rubsam & Horrmann Brewing Corp. utilizes Lukens Nickel-clad steel for the malt and cereal cookers. Instrument and control board and protective railings are of 18-8 stainless

PERFECT METER INSULATION . . .
FLAME-PROOF
S.E.I. NUT
THE SAFEST METER INSULATION
Tested by the U. S. Bureau of Standards, glass melanine laminates will meet the fire resistant specifications for inside use.
FIRE DEVIL S.E.I. NUTS will do the job. Samples and specifications on request.
FOR ADDITIONAL INFORMATION
PHONE . . . WIRE . . . WRITE
SERVICE ENGINEERS, INC.
Manufacturers of Industrial Plastic Products
FIRST NATIONAL BANK BLDG.
FORT WORTH, TEXAS

as is the outside of the steel wort tank. Close-up photographs of units are included.—INCO.

• Group IV

8.4

Corrosion in Natural Gas-Condensate Wells. pH and Carbon Dioxide Content of Well Waters at Wellhead Pressure. H. A. Carlson, Phillips Petr. Co. *Ind. Eng. Chem.*, **41**, 644-5 (1949) Mar.

The corrosion rate of natural gas condensate well tubing and equipment was found to correlate with the pH and carbon dioxide content of the well waters measured at well head pressures, but not to correlate with the pH or carbon dioxide content of the waters at atmospheric pressure, or with the iron or organic acid content of the water. Well water samples were taken from the flowing branch of the Christmas tree by a 10,000 psi transparent Jerguson gauge and the pH's were measured colorimetrically. In two wells where the pH of the water was 4.7 and the carbon dioxide partial pressure was 34.9 and 51.7 psi, corrosion of the tubing string was severe. In another well where the water pH was 5.9 and the carbon dioxide partial pressure was 14.7 psi, the tubing string was in excellent condition. Carbon dioxide accelerates the corrosion of steel at a pH of near 5.4, a soluble ferrous bicarbonate being formed.

8.4, 5.8, 5.7, 5.3, 6.1

NGAA Corrosion Research Project Committee Progress Report. T. S. Bacon, Lone Star Producing Co. Paper, NGAA 27th Ann. Conv., Ft. Worth, Tex., March 24-26, 1948. *NGAA 27th Ann. Proc.*, 5-7 (1948).

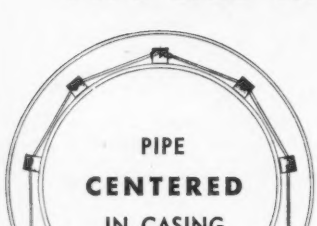
The activities of the Corrosion Research Project Committee of the NGAA (Apr. 1947-Mar. 1948) are reviewed and future research problems are outlined. Sodium bicarbonate and magnesium hydroxide have a buffering action sufficient to decrease the acidity and corrosiveness of well water without precipitation of calcium salts, which occurs if stronger alkalies are used. Organic inhibitors, such as the "Kontols" and bone oil are effective in wells having high concentrations of dissolved solids. Chromates and dichromates are effective in concentrations much lower than those used in oxygen-containing systems and the film remains effective for several days after the conclusion of the treatment. However, chromates tend to deposit solids in the flow strings of some wells. Protective coatings, especially thermosetting resins, are effective in the tubing strings but have been abandoned in Christmas trees. Alloys containing 5% or 9% nickel have been found to give very resistant tubing.

8.4

Report of Petroleum and Natural Gas Division. Fiscal Year 1947. Bur. Mines I.C. 7484. R. A. Cattell et al., Bur. Mines, Pittsburgh, Pa., Dec., 1948, 65 pp. (QF-31, M-66).

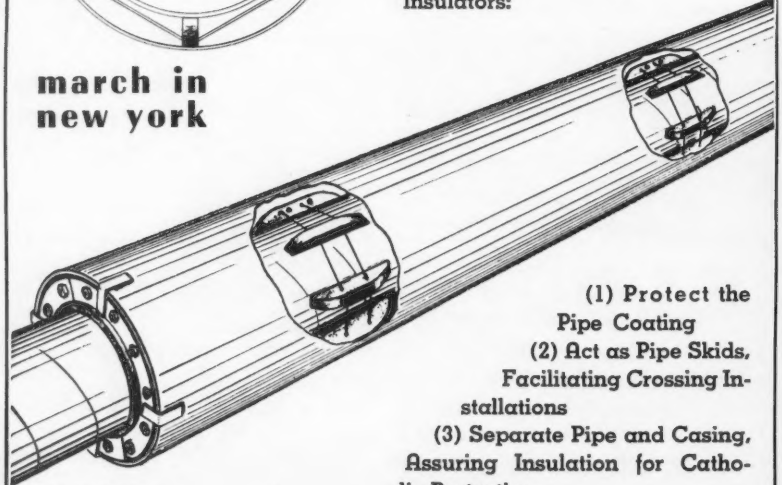
A report of activities of the Petroleum and Natural Gas Division of the Bureau of Mines for 1947 presents information on utilization of hydrocarbons in gas condensate type reservoirs, fluid properties, means of controlling corrosion in wells, engineering field studies, special properties of various reservoir oils, including charts of viscosity-API gravity of crude

WILLIAMSON "CONCENTRIC SUPPORT" PIPE LINE CASING INSULATOR*



This improved Williamson Pipeline Casing Insulator approximately centers the line pipe in the casing. This removes support of pipe from "WmSEAL" Casing Bushings, and facilitates their installation. In addition, Williamson Pipeline Casing Insulators:

march in new york



(1) Protect the Pipe Coating
(2) Act as Pipe Skids, Facilitating Crossing Installations
(3) Separate Pipe and Casing, Assuring Insulation for Cathodic Protection.

*Patents Pending

THE PIG WITH THE POKE CLEANS PIPE LINES

T. D. Williamson, Inc.
TULSA 9, OKLAHOMA

PLASTIC COATINGS

Vinyl and phenolic coatings, flame sprayed polyethylene and special cement linings, for protection against corrosion and/or contamination. Applications made in our plant or in the field to processing, storage and transportation equipment for oil, food, water, chemical and allied industries.

Other Metalweld services include Rubber and Koroseal lining, Metallizing, Sand Blasting and Welding. Inquiries are invited. Write for Bulletin (A).

Metalweld INC.
26th & HUNTING PARK AVE.
PHILADELPHIA 29, PA.

from Elk Hills Field, Calif., well spacing studies, secondary recovery methods, recovery of wax from crude petroleum wastes, laboratory studies of gravity drainage and the effect of temperature, and the recovery of oil from outcropping bituminous sandstones by hot-water washing. Petroleum chemistry and refining covers raw-material studies, relationship of fuel composition, properties and performance, utilization of petroleum products, analytical methods, thermodynamics of petroleum and the study of asphalts. Also included is information on natural-gas research, helium utilization and research and sulfur chemistry. A map of the "petroleum world" is included which presents pictorially an interpretation of current knowledge on the composition of petroleum.

8.4, 6.2, 4.3, 4.4, 7.6, 7.4

Frontier Refining Co. Installs Unisol Treating Plant at Cheyenne. H. A. Brown, Frontier Refining Co., and J. R. Strong, Universal Oil Products Co. *The Oil and Gas J.*, **47**, 236-237+ (1949) Mar. 24.

In the installation of the caustic-methanol mercaptan extraction process, known as Unisol treating, modification of old equipment is described. Gradually being replaced by Monel are the reboiler, lower section of debutanizer, tubes in the caustic stripping, channel head lining and caustic exchangers.—INCO.

8.4, 3.2, 4.3, 5.3, 3.5

Hydrogen Blistering Reported by Several Oil Companies. M. H. Bartz and C. E. Rawlins, Phillips Petroleum Co. Paper before API Div. Refining, Corrosion Sess., Mid-year Mtg., Houston, Apr. 4-7, 1949. *Petro. Proc.*, **4**, No. 8, 898-900, Appendix, 901, 904-906 (1949) Aug.

Cause of blistering of vessel walls and other refinery equipment is found to be attack of atomic hydrogen released by acid corrosion of steel. This same condition may lead to embrittlement of steel, at high temperatures. Use of corrosion resistant linings to keep corrodent away from carbon steel shells of vessels was adopted as one means of controlling hydrogen blistering. Few actual failures of blistered equipment were reported. By locating blisters before numerous or large cracks develop serious failures from this cause can be preevnted. Discussion includes causes of blistering, hydrogen embrittlement of steel, high and low temperature attack, early experiences, and control of H_2 damage. Photographs and tables are included. Twenty references.—INCO.

8.4, 4.6, 4.2, 5.3, 5.4, 5.2, 3.3, 5.9

Corrosion Problem in Offshore Drilling. A. E. Burns, Jr., *Petro. Eng.*, **21**, No. 4, B-86+ (1949) Apr. *Oil & Gas J.*, **48**, No. 2, 241+ (1949) May 19.

The three distinct areas of exposure involved on an offshore structure are: the continuously submerged area below the low tide level, the intermittently submerged area between the low and high tide level, and the area above the high tide level. Each of the areas presents distinctly different problems to the corrosion engineers and paint chemists.

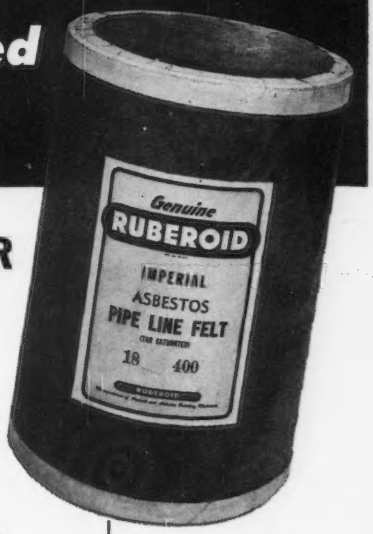
Practical procedures used for protecting each area are discussed briefly. A protective coating for the submerged and tidal-range areas is Catha-Coat, a completely inorganic composition containing an extremely high percentage of metallic zinc. It provides effective cathodic protection to the underlying steel due to its high zinc content. Catha-Coat is so hard that barnacles will not penetrate the film, thus the need for an antifouling paint is eliminated. Maintenance of accessible areas remains a problem as proper surface preparation is extremely difficult. Sand-blasting of corroded areas is effective when used in conjunction with Pre-Tek, a composition designed to penetrate the rust scale, bond to the metal, and replace the moisture and salt residue present in the rust scale.

8.4, 6.1, 2.2, 1.8, 2.3, 2.1

Kinetics of the Corrosion Process on Condensate Gas Wells. N. Hackerman and H. R. Schmidt, Univ. Texas, *Ind. Eng. Chem.*, **41**, No. 8, 1712-1716 (1949) Aug. (See also: **Identification of Corrosion Products—Using Measurements of Film Thickness and Mass,** by C. K. Eilerts, *Ind. Eng. Chem.*, **41**, No. 8, 1716-1717 (1949) Aug.)

Rate curves for corrosion of SAE 1020 steel in a number of gas-condensate wells were obtained for relatively long periods of time. Coupons' surfaces were examined microscopically and composition of corrosion products was determined by x-ray and diffraction methods. Results substantiated corrosion classification proposed earlier, namely, corrosive, mildly corrosive, due to less aggressive corrodent, non-corrosive, even though highly active corrodent is present. Equations for linear portions of curves are given. An inverse relationship between thickness of surface layers and steady reaction rate is shown to be obtained for first 2 of 3 corrosive types. In third type, a change in nature of film is evident, which is ascribed to presence of inhibitors, natu-

PIPE PROTECTION
(in a protected package)



BETTER and LONGER
Pipe Line Protection
with RUBEROID
ASBESTOS FELT

Pipe Line engineers have found that under most soil conditions a saturated asbestos felt and enamel coating provide by far the best protection against both the physical and corrosion hazards to which underground lines are subjected.

Ruberoid Imperial Asbestos Felt is highly acclaimed for its long-fibred strength (asbestos — not wood pulp) and *lasting* protection against jagged rocks, electrolysis, soil distortion and settlement. Long range economy in pipe maintenance is assured by the enduring performance of Ruberoid Imperial Asbestos Felt.

***Protected Package** — an exclusive Ruberoid development. The weather hazards of field-wrapping jobs are substantially reduced by this new package which is constructed of waterproofed kraft and a special edging seal.*

National Distributor
S. D. DAY COMPANY
2017 West Gray
Houston 19 Texas
"Serving All Pipe Lines"

RUBEROID PIPE LINE FELTS
The RUBEROID Co.
EXECUTIVE OFFICES: 500 Fifth Ave., New York 18, N. Y.

ral or injected, in sufficient concentraton for conditions of gas production. It is postulated that diffusion of corroding agent to metal is steady-rate controlling factor and that this in turn depends on nature of surface layers.—INCO.

8.4

Corrosion Characteristics of Concrete River Clamps. *World Oil,* **128,** No. 10, 170 (1949) Feb. 1.

Examination of 20-inch pipe lines indicates that certain precautions must be undertaken to prevent clamps from developing a site for augmented corrosion. Unless the wrap is doubled or trebled in the area covered by the clamp, the slight movement of the pipe will eventually break the coating at the edge of the weight, exposing bare metal in a narrow strip which sometimes extends one fourth the circumference of the line. Another failure is the formation of transverse fractures along the lines of buried reinforcing steel. Water invades the material through pores and if carrying oxygen, attacks the steel. The rust thus formed, being confined within the pores of the matrix material cannot escape and swells eventually developing pressures which split the weights and in some instances even break in tension the bolts uniting the clamp halves.

8.4

Galvanic Corrosion in Oil and Gas Well Fluids. F. L. LaQue. Paper, NACE South Central Regional Meet., Tulsa, September 20, 1948. *Corrosion,* **5,** 86-91 (1949) Mar.

Factors controlling galvanic corrosion in oil and gas well fluids are considered. In the absence of oxygen, corrosion is accelerated by the release of hydrogen as gas from the cathode. Depolarization of steel surfaces, i.e., removal of protective film, by erosion would accelerate corrosion in the absence of air, as would the presence of a continuous body of electrolyte sufficient to cover a substantial area of the more noble metal involved. Since corrosion is generally under cathodic control, galvanic action increases with increase in exposed cathodic area, relative to anodic area. In an oil well, tubing made of alloy steel, or even stainless steel, nickel-plated steel or Monel, can be run inside a carbon steel casing without risking accelerated corrosion, since the intervening electrolyte would be substantially free of oxygen, cathodic polarization would stifle the galvanic cell, and the area of the tubing would be less than that of the casing. Results of galvanic corrosion tests in sea water and in Anahuac drilling mud are tabulated.

• Group IX

8.9, 5.9, 3.5, 3.3, 5.4

Preservation of Reserve Fleet Vessels. *Marine Eng.* F. E. Hickey, Paper read at the American Merchant Marine Conference sponsored by the Propeller Club of the United States, held in New York, 13th-15th October, 1948.

The method and manner of preservation in effect include preparation and treatment of vessel hulls, machinery and equipment which suffered slight to serious corrosion, accumulation of salt deposits and scum coatings during war service. In view of the tremendous area that must be treated within a reasonable time, it has been found advisable to ac-

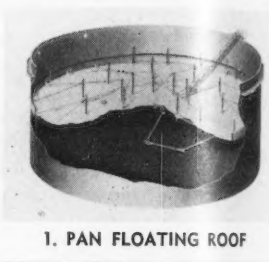
To cut down
CORROSION
in storage tanks

use the
Horton Floating Roof

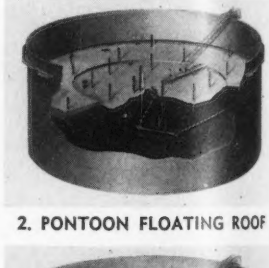
You can reduce the amount of corrosion on the inside of oil storage tanks by equipping them with Horton Floating Roofs. As the view above shows, this roof floats directly on the liquid in the tank. The elimination of the vapor space practically eliminates corrosion on the underside of the roof and the inside of the tank shell above the liquid. The corrosion of the tank bottom is also reduced materially because relatively little rust drops from the roof and shell.

The Horton Floating Roof is available in three types:

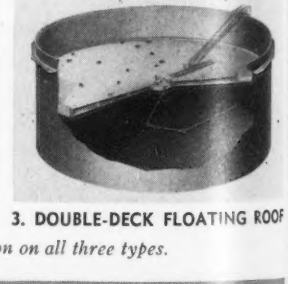
1. ***Horton PAN Floating Roof***—provides maximum economy for tanks storing liquids of low volatility. The bottom of the deck is in contact with the liquid at all times and there is no vapor space between the roof and the liquid.
2. ***Horton PONTOON Floating Roof***—Pontoon section covers half the area of the tank. Vapor caused by boiling when temperatures are high collect under center of roof, providing insulation against further boiling. Entire bottom of roof normally in contact with liquid.
3. ***Horton DOUBLE-DECK Floating Roof***—most recent design of all three—has double deck with insulating air space over entire area of tank. Bottom deck is in contact with the liquid in the tank at all times.



1. PAN FLOATING ROOF



2. PONTOON FLOATING ROOF



3. DOUBLE-DECK FLOATING ROOF

Write the nearest office for information on all three types.

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3 ..... 2137 Healey Building
Birmingham 1 ..... 1552 North 50th Street
Boston 10 ..... 1060—201 Devonshire Street
Chicago 4 ..... 2119 McCormick Building
Cleveland 15 ..... 2248 Guildhall Building
Detroit 26 ..... 1561 Lafayette Building
Havana ..... 402 Abreu Building
Houston 2 ..... 2159 National Standard Building
Los Angeles 17 .. 1552 General Petroleum Building
New York 6 ..... 3328—165 Broadway Building
Philadelphia 3 .. 1661-1700 Walnut Street Building
Salt Lake City 4 ..... 563 West 17th South Street
San Francisco 11 .. 1272-22 Battery Street Building
Seattle 1 ..... 1363 Henry Building
Tulsa 3 ..... 1640 Hunt Building

Plants in: BIRMINGHAM, CHICAGO, SALT LAKE CITY, and GREENVILLE, PA.

celerate by manual and mechanical means the removal of scale, salt deposits and scum accumulated during vessel operation from the hull exterior surfaces and vessel equipment prior to preparation for final preservation compound coatings over the rate of removal that could be accomplished by application of a penetrative type compound only. Concurrently with manual and power-tool descaling operations, one fleet conceived and partially developed the idea of utilizing fire pumps and deck stand monitors to descale vessels sides and decks by high-pressure water blasting. Results to date are highly encouraging, indicating immediate large savings in man-hours and over-all costs, and producing a surface ideally conditioned for applications of primary preservation treatment. Where water blast descaling is not complete to the extent that final preservation treatment may be applied at once, it greatly speeds the entire preservation program. Experience to date has shown that water blasting will remove an average of 80 percent of the scale accumulation from the hulls of all vessels in the fleets and the descaling to the extent is accomplished with approximately 30 percent of the man-hours that would be expended if the same descaling was done manually and with usual power tools. Water blasting is accomplished by use of approximately 200 gallons per min. at 250 lb. sq. in. gauge, using straight bore nozzle throats to obtain a compact discharge stream for maximum impact when operating with the nozzle approximately 12 feet from the surface being blasted. Additional information will be available after further development. The problems brought about by fungi and mould growths are of serious concern, particularly where insulation of electrical equipment and windings must be preserved. The attack on this problem has been two-fold: first, a special type insulation quality air drying varnish containing a fungicidal agent is used where needed after all traces of oil, grease or debris have been removed from electrical windings; and second, the Division of Biological Sciences, University of Pittsburgh, is now under contract for the development of a fungicidal compound to kill existing growths and to inhibit new growths for an approximate two-year period.—TIME.

8.9, 6.2, 6.3, 2.2, 4.2, 3.7

Report of Committee 13; Application of Corrosion-Resisting Materials to Railroad Electrical Construction. Assn. of American Railroads, Washington, D. C. Report of Committees, 1947, p. 28-37.

Corrosion-resistant ferrous and nonferrous alloys intended for railroad electrical applications, such as overhead catenary constructions and wire crossings, were exposed: 1) to accelerated corrosion in the smoke jack of an engine house for 1-3 yr, 2) over a track near salt water under average corrosive conditions for 8-11 yr, and 3) in a railroad tunnel over the center of the track for 5-8 yr. The tunnel represents about the most severe corrosive conditions on a railroad using steam locomotives.

Materials with relatively good corrosion resistance in the accelerated smoke jack test generally gave good results in the service tests in the tunnel and near salt water; however, it seems impossible to predict accurately the loss of various materials in service from their behavior in the accelerated test.

Strand samples of hard-drawn copper and of various bronzes were generally the most resistant. Round samples of cast 18-8 chromium-nickel stainless steels and strand samples of the 18-8 stainless steel containing 2.5% molybdenum were satisfactory. Buffing of 18-8 steel rounds apparently increased the corrosion resistance.

Wrought iron had the greatest loss of weight of all samples. Large losses were also recorded for aluminum alloys and for low carbon steel. Malleable iron and a copper bearing steel were somewhat better than low carbon steel. Exposure to locomotive smoke results in a short life for: 1) brasses containing more than 20% zinc and 2) galvanized or copper plated steel. Steel wires protected by copper tapes and a steel core under copper wires were rusted, although the copper was unattacked. Asphalt paint did not prevent the corrosion of copper-plated steel strand, but a strand of seven copper-covered steel wires surrounded by twelve copper wires was in good condition.

Test results should be applicable to overhead bridges subjected to the direct blast of steam locomotives.—PDA.

INDEX TO ADVERTISERS
JULY, 1950

Vol. 6 **No. 7**

	Page
Allied Chemical & Dye Corp., Barrett Division	xiii
Amercoat Corporation	Inside Front Cover
American Brass Company	xii
American Smelting & Refining Co., Federated Metals Division	14
Atlas Mineral Products Co.	v
Bauer & Black Division, The Kendall Company	11
Bechtel Corp. & H. C. Price	vi
Cathodic Protection Service	28
Cathodic Servicing Co.	x
Chicago Bridge and Iron Company	38
Control Corporation	6
Corrosion Directory	10
Dixie Tank & Bridge Co.	6
Dowell Inc.	ii
Dresser Mfg. Division	13
Duriron Co., The	Inside Back Cover
Electro Rust-Proofing Corp.	32
Farley Co., Inc.	25
Gama Industries	22
General Paint Corp., Hill, Hubbell Division	40
Gerrard, A. J. & Co.	8
Glass Fibers, Inc.	24
Good-All Electric Mfg. Co.	viii
Hills-McCanna	5
Humble Oil & Refining Co.	21
Johns-Manville	3
Koppers Co., Inc.	23
Mavor, James E. Co.	29
Mayes Bros., Inc.	i
Metalweld, Inc.	36
Mutual Chemical Company	16
Natasco Co.	31
National Association of Corrosion Engrs.	5, 18, 26, 39
National Carbon Division, Union Carbide & Carbon Corp.	17
New Jersey Zinc Co.	19
Ohio Steel Foundry Company	20
Owens-Corning Fiberglas Co.	xi
Perrault Bros.	15
Pipe Line Service Co.	9
Pittman, Wm. G.	18
Prufcoat Laboratories, Inc.	14
Ruberoid Co., The	37
Service Engineers, Inc.	35
Standard Pipeprotection, Inc.	7
Stearns, D. E.	Back Cover
Tapecoat Company, The	33
Union Carbide & Carbon Corp., National Carbon Division	17
Williamson, T. D., Inc.	36

WANTED!

To Replace Exhausted Files at Central Office NACE

Copies of

CORROSION for APRIL, 1950

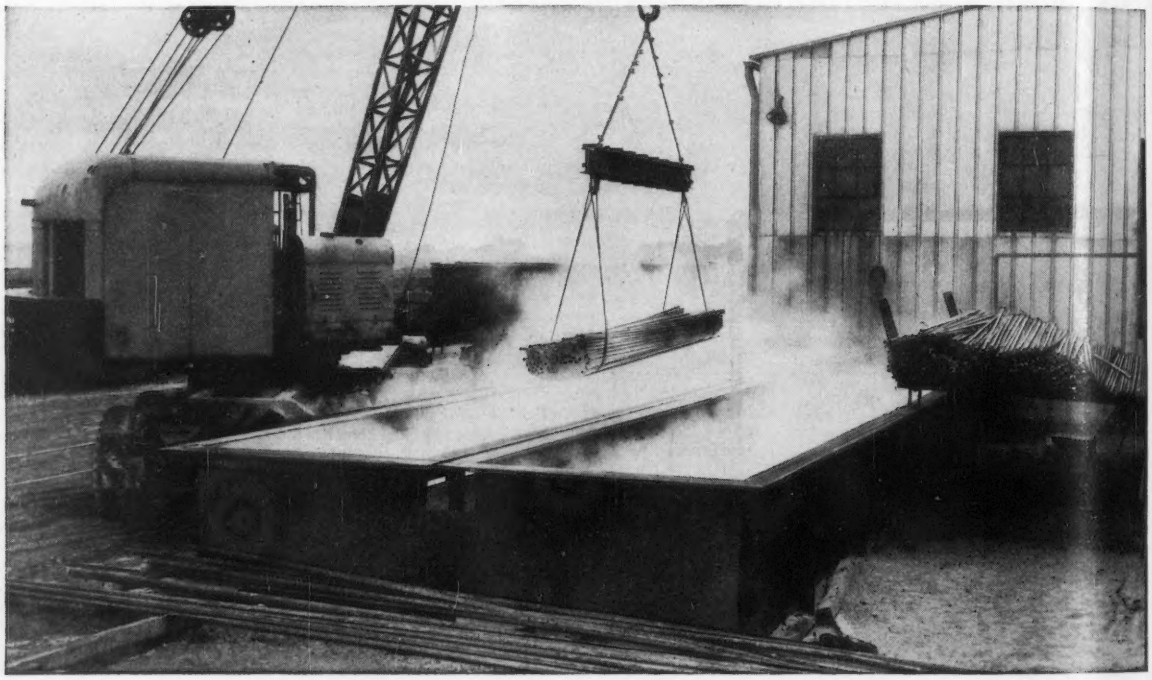
If you have a copy of this issue, intact, for which you have no further need, NACE will pay you 50c for it delivered to 919 Milam Building, Houston, Texas.

Copies of the issue are needed to service requests for the issue from new members and others which the association is unable to honor because of the unanticipated heavy demand.

YOUR COOPERATION WILL BE APPRECIATED

Watching pipe protection costs?

First cost often doesn't tell the whole story! It omits the *major* expense of too many pipe-protection jobs—the cost of maintenance. That is why today's corrosion engineers insist on investigating *every stage* of a protection process before placing a job. They have learned that the *life* of the pipe—the years it can resist every corrosive agent—depends upon how soundly the pipe is conditioned and how scientifically the protection is applied.



WHAT'S HAPPENING HERE is just the first step in Hill, Hubbell's exclusive *controlled* process of pipe protection. Bare pipe is dipped in hot caustic solution to remove every trace of cutting oil and grease. Then it is rinsed in clean hot water, ready for the drying oven and the Hill, Hubbell-engineered Roto-Grit-Blast cleaning and etching machine.

Only this kind of conditioning can prepare pipe for *positive* bonding of the protective layers. And only the skillful *factory* application of these layers can assure the long-range service that keeps protection costs low.

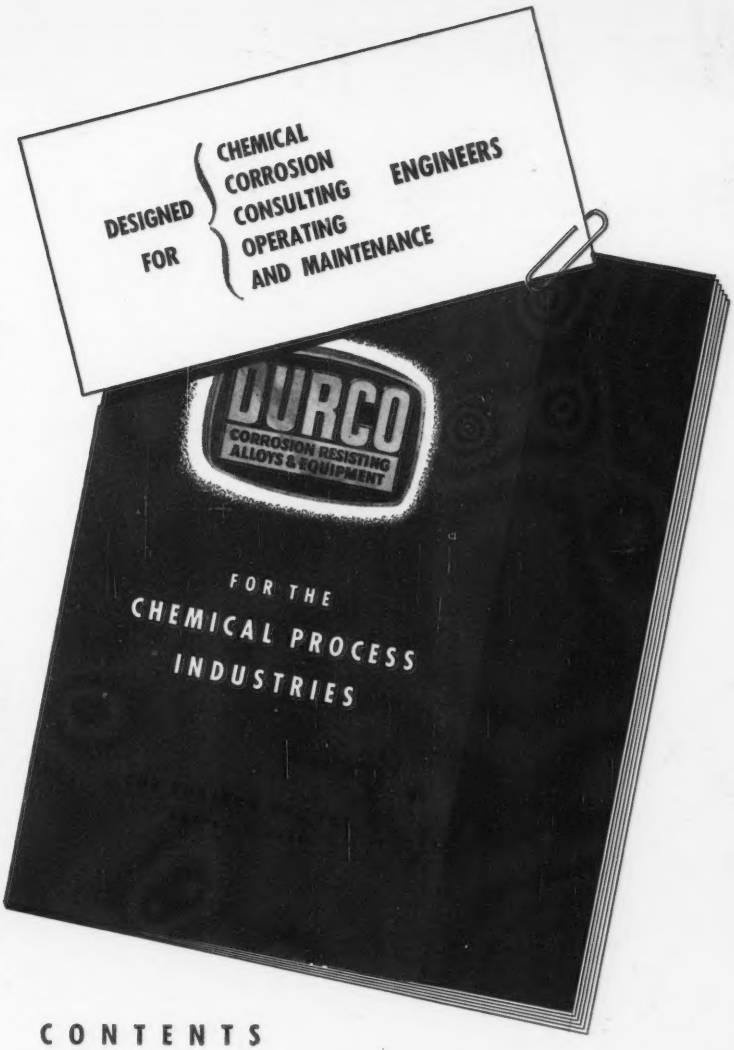
Hill, Hubbell and Company

Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

For a Quarter Century the Pioneer in Pipe Protection

THE NEWEST, MOST COMPLETE Catalog of Corrosive-Handling Equipment



Get *your* copy of this 12-page general catalog of the latest answers to corrosive handling problems. It is a complete, quick-reference file on corrosion-resistant equipment and alloys.

The booklet covers Durco's entire line of special alloys, process equipment and services. Essential data on features, sizes, capacities and applications are boiled down and organized so you can *quickly* spot what you want. Your eye travels directly from a product to the alloys it is made in, then to applications and sizes and capacities.

Each of Durco's specialized, corrosion-resistant alloys is treated from a metallurgical, physical and chemical service-range standpoint.

As an extra help, the catalog names the detailed bulletins available on each item and a business reply card is enclosed to make it easy to get those you want.

CONTENTS

Durco Service
Production Facilities
Testing and Inspection
Technical Service
Alloys
Resistance of Durco Alloys to Corrosive Solutions
Special Recommendations

Equipment
Anodes
Bar
Ejectors
Fans, Exhaust
Heaters, Immersion
Heat Exchangers
Jets, Steam

Equipment
Pipe and Fittings
Pumps
Jets, Elbow
Kettles
Nozzles, Mixing
S-Bend Condensers
Sinks

Equipment
Strainers
Tanks
Tank Outlets
Tower Sections
Valves, Angle
Valves, Check
Valves, Diaphragm

Equipment
Valves, Float & Relief
Valves, Y
Valves, Plug
Lubricated
Non-Lubricated
3-Way
Requesting Recommendations

Send for your copy of General Catalog M, now. Just mail the coupon or write a note on your letterhead.

THE DURIRON CO., INC., DAYTON 1, OHIO

Please send me, without obligation, a copy of your new General Catalog M.

Name .....

Title .....

Company .....

Address .....

City ..... *State* .....

★ Thorough Inspection ★ Light Weight
★ Simple to Operate ★ Dependable Service

D. E. STEARNS
SHREVEPORT, LOUISIANA

POST OFFICE BOX 1234

A Dependable Organization
providing the
Finest Holiday Detector Equipment
for the
Entire Pipe Line Industry

Via Air - Anywhere

BETTER COATINGS CONSERVE STEEL